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A MANUAL

FOR THE

PRACTICE OF SURGERY.

BY

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WITH SEVEN HUNDRED AND TWENTY-SEVEN ILLUSTRATIONS.

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AMERICAN PUBLISHERS' NOTICE.

AMERICAN surgeons have unmistakably signified their appreciation of Mr. Bryant's *Practice of Surgery* by demanding four editions since 1879. The third American edition, like the second, was reprinted from the third English edition, and in order to cover the advances in Surgery made in the interval, it was subjected to a very thorough revision by Dr. John B. Roberts, a former pupil of Mr. Bryant. It has been thought well to reprint the fourth English edition without alteration, since it comes fresh from the pen of the Author, and it may be noted that he has seen fit to accept many of Dr. Roberts' additions. The two volumes of the English edition have been arranged to occupy one in the American reprint—a change which conduces both to convenience in handling and comfort in reading.

NOVEMBER, 1884.

PREFACE TO SECOND EDITION.

A SECOND EDITION of this manual having been called for, I have availed myself of the opportunity to make some alterations in the substance as well as in the arrangement of the work, and, with a view to its improvement, have recast the materials and revised the whole. I have also, to make the work more complete, added much new matter, including chapters on diseases and injuries of the eye and ear, some remarks on dental surgery, on the diagnosis of ovarian tumors, and on deformities, together with at least one hundred new wood-cuts.

I am well aware that I have failed to realize in the execution of my task the ideal standard I at starting proposed to myself, and I knew, when I first undertook to write the book, how difficult it was to compress the treatment of the vast range of subjects included under the title of "Surgery" into one volume, but my object was to offer such an epitome of the main principles and methods of practice as should be serviceable to the student and practitioner; and from the reception the first edition of this work, published in November, 1872, has met with in Great Britain and America, I feel justified in saying that I have not failed in the attempt, and that the book supplied a want felt by the professional public.

To the many reviewers who have acknowledged my labors so fairly and so fully my thanks are clearly due, but still more to the profession, which has welcomed my humble services so kindly.

Fully alive, therefore, to the generous appreciation of my past work, and assuring my readers that no pains have been spared to bring the present up to as high a standard as my time and opportunities have allowed, I submit it in all confidence to the kind consideration of my professional brethren as no unworthy exposition of modern British surgery.

In its execution I have endeavored to acknowledge on all occasions the claims of others and whatever merit or novelty may attach to their views or operations,

for my wish has been to represent not so much my own opinion, as the position of surgery at the time I write.

It only remains for me to express once more my obligations to Mr. Thomas Turner, the treasurer of Guy's Hospital, by whose kindness the materials in the unrivalled collections of that institution were placed at my disposal; to my colleagues, Drs. Moxon, Goodhart, and Purves, Messrs. Howse, C. Higgens, and Moon; and to Mr. Wesley, the artist who has so ably illustrated these pages.

Since I first undertook this work death has deprived me of two colleagues, Mr. Poland and Dr. Phillips, both of whom rendered me many friendly services and much valuable assistance. I refer to their names with gratitude and regret.

53 Upper Brook Street, Grosvenor Square,
March, 1876.

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"Only the association of medicine with surgery forms the perfect physician. The physician who is deficient in the knowledge of one of these branches resembles a bird with but one wing."

Art of Life (Ayur Veda): early Sanscrit, first century of Christian era.

"I dressed his wound, and God healed it."

Ambroise Paré.

"All that we have to do is not to obstruct Nature in the execution of those offices, to which she is generally fully equal, in which we can lend her no assistance beyond removing impediments out of her way."

P. Pott, 1773.

"Surgery consists in curing a disease rather than in the removal of it by mechanical means. But so differently do most think upon this subject that a surgeon who performs most operations and gives most pain is commonly thought the best."

John Hunter, MS. Lectures, 1787.

THE

PRACTICE OF SURGERY.

INTRODUCTORY CHAPTER.

SURGERY is of a twofold nature. It is a science and also an art—a department that requires to be known, and another to be practised. The science embraces a knowledge of the character, the causes, and the effects of disease and injury, and also of the processes by which they are best repaired; the art consists of the treatment of diseases or injuries as they present themselves, which, to be successful, must be based upon the science. At the bedside the phenomena of disease must be studied, its symptoms recognized and duly weighed; in the post-mortem room its effects are to be traced. The great object of the student, therefore, should be clinical and pathological investigation, the study of the living and the dead, since it is by these alone he can hope to acquire a solid basis on which to ground his practice.

The external features of a local disease may appear the same to the student as to the most accomplished surgeon; whereas the phenomena of disease are often perceptible to the latter alone, the acquired art of observation and the unconscious influence of experience giving to the mind of the one a power of recognition and interpretation which is denied to others.

It is to the acquisition of this power, therefore, that the student should devote his energies, and to this end cultivate the art of observation, for by it he will not only gain the power of seeing correctly, but also of interpreting the meaning of what he sees, and will thereby acquire a diagnostic acumen which cannot otherwise be obtained.

It is now necessary to consider by what method a correct opinion can be formed in any given instance, how sources of fallacy are best eliminated and a good diagnosis established, for it cannot be too forcibly impressed upon a student's mind that the treatment of a case will not be successful unless based on a clear understanding of its wants, and that these can never be duly appreciated where a correct diagnosis of its nature has not been made.

The mind of the surgeon should invariably be judicial; it should possess nothing of the advocate, but be so regulated as to be able to put aside all prejudices and preconceived ideas, and avoid the advocacy of all unsupported theories and hypotheses; it should be open to accept clinical phenomena as they are observed, and arrive at a conclusion cautiously and clearly after duly balancing the facts of the case, and carefully weighing the possibilities and probabilities of its nature.

To form a diagnosis of a case mainly on probabilities as indicated by symptoms may be a ready, but it will always prove a rash, proceeding. To form it on possibilities will be a safe, although perhaps a less expeditious, course. The surgeon who acts upon the first method must at times fall into grave errors, although his diagnosis will often appear brilliant and may be successful; while he who habitually forms an opinion after taking into consideration every possibility of the case, and comes to a result by a process of exclusion, must surely, on the whole, be more certain in his ends, as he will be safer and sounder in his practice. I lay down, therefore, the following proposition as a guiding principle of investigation applicable alike to all cases of injury as well as of disease:

That in the diagnosis of a case every possibility of its nature should be entertained, and a conclusion arrived at by a process of elimination; each possibility should be separately considered and weighed, and the most probable finally accepted, a diagnosis wholly framed on probabilities being most hazardous.

For example, a tumor at the femoral ring may *possibly* be either an abscess, an aneurism, a varix, cyst, hernia, enlarged gland, or a new growth. An abdominal tumor may be ovarian, uterine, peritoneal, vesical, splenic, fæcal, renal, or hydatid. Its probable nature will be best arrived at by eliminating each of these possibilities *seriatim* after a due consideration of all its clinical symptoms, the most probable diagnosis being finally accepted on evidence both negative and positive.

With the above great principle of practice as a guide in clinical investigation, I now proceed to consider how any injury or disease is to be investigated, confining my observations to classes of injury and disease. I do not propose, however, to point out here the exact mode in which it is well to examine a case or to report it—for a report is only a written examination—although at pages 21–23 an outline will be seen which may probably be found of service. I drew it out many years ago, when surgical registrar at Guy's, where it has been generally followed ever since.

How to Investigate a Case.

When a surgeon is called to a patient, his questions naturally apply first of all to the seat of disease or injury. Is it in the head, chest, abdomen, or extremities? He will then ask as to its duration or when the injury was received; or when was the disease discovered? If a case of injury, his inquiries would tend to elicit the exact mode of its production, the force employed, and the character of the instrument by which it was produced; for these points are of essential importance under all circumstances, and in head injuries they often give the key to the solution of many questions. By these means the exact seat of injury will probably be indicated, and the surgeon will be led to make a close examination of the injured part; but he should never fail to assure himself that all other parts of the body are sound and in working order, and that no other is involved in disease or is the subject of injury; for it would be a forlorn hope to amputate for a crushed limb when associated with a ruptured liver, or to reduce a dislocated joint when combined with some fatal internal lesion.

In a case of injury to or disease of the head or nervous system, the most important point the surgeon has to determine has reference to the exact seat of the affection. Is it confined to the soft parts covering the bone, or are the contents of the skull in any way involved? because, in the former, the affection is comparatively of small importance; whereas, in the latter, its gravity cannot be too highly estimated. Scalp wounds, however severe, have, as a rule, a successful ending; whilst brain injuries, however trivial, should always be regarded with apprehension, for they may lead to the most serious complications.

When no signs of brain disturbance after an injury have been observed, the diagnosis is not difficult; for without symptoms, local or general, a surgeon may be excused from entertaining the idea of brain complication, although he should know that cases of fractured base have taken place without any symptoms to suggest the presence of such an injury. When indications of brain disturbance exist, the difficulty arises; for it cannot be too firmly impressed on the student's mind that the same symptoms may be produced by concussion as by compression of the brain, and that bone pressing on the brain, and blood effused upon its surface or within its structure, give rise to precisely the same phenomena; he should know that the symptoms produced by apoplexy the result of a ruptured vessel, and by hæmorrhage into the brain from an injury, are almost identical, and that those produced by what is called functional disturbance of the brain closely resemble those caused by organic mischief. Whilst, therefore, it is imperative on the student of surgery to remember that a variety of different conditions may give rise to apparently identical clinical symptoms, he must know that the clinical *history* of each of these cases will on inquiry be found to differ widely, and that it is to the collateral evidence of the case he must look to find the right clue to a successful diagnosis.

Where no clinical history can be obtained, the difficulties of diagnosis are indeed great; thus, when a surgeon is called to see a man who has been found in the street insensible, who is, in fact, in an apoplectic condition, and has, at the same time, some external evidence of injury to his skull, and may perhaps also smell of spirits. The questions that arise in the surgeon's mind under these circumstances are very conflicting. Did this man have a fit and then fall, or are the symptoms due to a brain injury the result of an accident? Was he knocked down and injured, or was the injury the consequence of a fall? Are the symptoms caused by drunkenness, or how far are they complicated with it? Are they the result of blood-poisoning from kidney disease, or poisoning by opium?

To unravel all these points great care and discrimination are required. Too much, indeed, cannot be bestowed upon the task, because to treat an apoplectic seizure or a case of severe brain injury from external violence for drunkenness is a grave error; but, unfortunately, it is one which is not uncommon. To mistake drunkenness for apoplexy or severe head injury is, perhaps, a less grave, although it is, without doubt, a serious, fault. As a matter of policy, however, it is generally a wise rule to regard all these suspicious cases from the more serious point of view, and to watch and wait for symptoms to indicate the practice that should be pursued.

What I wish, therefore, to impress upon the student is the necessity of bearing in mind that all these different conditions alluded to present to the surgeon many features in common, and that a correct diagnosis can only be arrived at by a process of exclusion. The possibilities of the case having thus been reviewed, the probabilities can only be weighed by a rigid inquiry, even into the minutest circumstances that can be ascertained.

In cases of local paralysis the difficulties of diagnosis are very great. Is the cause a *central* one—that is, is it in the brain or cord? or is it *peripheral*—at the termination of the nerves? or is it *local* without being quite peripheral? If one or two of the former causes be in operation, the history of the case will probably form a true guide to the surgeon, and in the latter some local injury to the nerves supplying the part, some tumor or aneurism pressing upon the nerves, will probably be found; or perchance it may be a case of lead palsy or infantile paralysis. But, under any circumstances, a true diagnosis can only be made by eliminating from consideration the many possible causes and adopting the most probable.

Again, *it should be an invariable rule of practice in every case of injury or disease to compare the sound with the affected side of the body.* In the diagnosis of a dislocation or fracture, the information gained by the comparison often furnishes at a glance to the experienced eye a true suggestion as to the nature of the accident, and in joint disease any effusion into a joint or enlargement of the bones is, as a rule, readily detected.

The nature of the disease or injury being thus suggested to the mind through the eye, the suggestion remains to be confirmed or corrected by a careful manual examination, by the other clinical symptoms, and by the history of the case, the facts elicited by the sight, by the hand, and by the ear being made separately available, and the conclusion drawn after a careful balancing of the probabilities and possibilities of the case. The diagnosis will be well established when all these different modes of investigation lead to one conclusion.

In surgery, as in medicine, the student must educate the eye to see and the hand to feel, and the task is by no means simple or easy; indeed, it is one of the most difficult to learn, and cannot be begun too early in his professional career. Reading will not help, nor thought aid: personal experience at the bedside alone will supply the want.

To recognize the existence of a wound or the deformity of a broken bone may not be difficult, but to read aright the endless phenomena which a wound presents, and to make out the character or tendency of a fracture, require much experience. To see that a swelling exists in a part is open to the uneducated eye, but to recognize the various aspects that different tumors assume, to make out their form, position, and attachments, to estimate their consistence, to recognize the fluctuation of fluid, whether superficial or deep, and to detect pulsation, require considerable tactile power and long education. What education also is demanded in order to read the phenomena presented in diseases of the eye or the skin! "No study of the written observations of others could enable any to appreciate those endless varieties of the pulse which entirely baffle description, or to distinguish between the warmth of the skin excited by various accidental causes and the pungent heat accompanying the first stage of pneumonia, or acquaint him with the shrunk and shrivelled features derived from the long-continued disease of the abdominal viscera, the white and bloated countenance often attendant on changes in the functions or structure of the kidney, the squalid and mottled complexion of the cachexia dependent upon the united effects of mercury and syphilis, the pallid face of hæmorrhage, the waxen hue of amenorrhœa, the dingy whiteness of malignant disease, the vacant lassitude of fever, the purple cheek of pneumonia, the bright flush of phthisis, the contracted features and corrugated brow of tetanus; all which shades of countenance, with many more that might be enumerated, are distinctly recognized by the experienced eye." Yet all this, and something more, is to be acquired by means of trained observation, and no labor on the student's part should be considered too great for its attainment.

Diathesis.—This subject claims the attention of the surgeon, on account of its undoubted bearing on practical surgery. In the *strumous*, *scrofulous*, and *tubercular*

diatheses—all of which appear to be closely allied—there is, no doubt, a tendency to glandular enlargement, the formation of caseous deposits, and a low kind of inflammatory action, whether in the bones, joints, skin, or lungs; but beyond these clinical facts we know nothing. Disease in subjects who have these diatheses is precisely identical in its essential nature with the same disease in others who have them not. It may be modified in its course by the diathesis, but it is the same. These names have, likewise, no special signification when applied to local affections.

It is important to bear this fact in mind, for there can be little doubt that the expressions "strumous disease" and "scrofulous disease" have had an injurious influence on the practice of surgery. They have too often led the surgeon (and misled the public) to regard a local affection in a strumous or scrofulous subject as incurable, as depending on some constitutional condition, and not on a local cause. In disease of the joints this error has been much felt, and should be rejected.

The investigations of Drs. Sanderson and Fox in England, and Dr. Waldenburg abroad, tend, however, to show that the *scrofulous* diathesis, in which there is a tendency to inflammation of a low type, gives rise, under some circumstances, to *tuberculosis*, and that local inflammatory affections of a chronic nature are specially prone to be followed by tuberculous disease.[1] The gray granulations or tubercles are apparently derived from some pre-existing inflammation; from the absorption into the blood of the *caseous* or *cheesy* deposits which are supposed to be the residue of an antecedent inflammatory action —whether in the bones, joints, glands, or lungs, and these are subsequently disseminated in the form of miliary tubercle. Niemeyer, indeed, maintains that "the formation of tubercle never takes place unless preceded by pneumonia terminating in caseous infiltration of the pulmonary tissue." To the surgeon this aspect of the case is of immense importance, for it is clearly his duty, under these circumstances, to hasten the recovery of local suppurative disease as much as possible, and, where this cannot be carried out, to remove it. For let it be once shown that local disease has a direct influence in producing constitutional dyscrasia—call it by what name we will—and the necessity of dealing actively with chronic local affections becomes a duty. I have occasionally acted upon this principle with the best results, and in more than one case in which there was progressive lung mischief associated with a disorganized knee have found the lung affection speedily subside after amputation. It must likewise be admitted that a local disease in a strumous subject may be as amenable to treatment as it is in a more healthy one. The treatment may, indeed, require some modification from the fact of its occurring in such a subject, but the principles of practice in both the strumous and the non-strumous are the same, although we know that in the former all diseased action is of a low type, and that there is always a greater tendency to degenerative changes than we find in other subjects. Some pathologists have been bold enough to say that the scrofulous diathesis is the consequence of hereditary syphilis, but evidence is wanting to substantiate this view.

Hæmophilia, or the *hæmorrhagic* diathesis, as the result of heredity, is a subject of peculiar interest to the surgeon, and is to be distinguished from a temporary disposition to bleed, which is present in purpura or leucæmia, and is often acquired. It attacks the boys of a family rather than the girls, and when bleeders beget children all, as a rule, appear healthy, but when the girls have families their boys, as a rule, are bleeders. It may appear at the very earliest period of life. It manifests its presence by a peculiar tendency to bleeding on the slightest provocation, and by the difficulty there is in arresting hæmorrhage when it does take place. The surgeon should always have before him the possibility of his patient being a subject of this diathesis; for, although it would not prevent the performance of any operation essential to save life, it would materially affect the question of operating for any reason of expediency, and would influence the practice adopted.

The bleeding may take place from any part of the body or into any cavity. It may be venous or arterial, and may occur without any definite cause or follow some slight injury. The swelling of the joints which takes place in this affection in some cases is due to hæmorrhage, but in others to serum. In a drawing in my possession the synovial membrane was found after death covered with beautiful fine fringes stained a deep-orange color from effused blood. Sir W. Jenner states that in those cases "the tissues are soft, and bruise easily; the blood is slow in coagulating, although it coagulates as firmly as in health—that is, blood is formed rapidly, and there is a tendency to plethora of the small vessels—and that when the patient is looking his best, injuries have the

[1] *Die Tuberculose und Scrofulose*, von Dr. L. Waldenburg (Berlin, 1869).

worst effect and spontaneous hæmorrhages are most likely to occur." In this disease, therefore, he advises a mercurial and saline purge every three weeks, dry food, with a considerable portion of dry fibrinous meats, and plenty of open-air exercise, great care being observed to avoid injuries. The bleeding, as a rule, ceases spontaneously. In the acquired disease iron is of great value.

Cachexiæ.—Do they exist? Is there any definite aspect associated with any definite disease? Is there a cancerous cachexia? I have little hesitation in stating that in practice no such thing can be established, and that a large number of patients suffering from cancer are as healthy-looking as any other class, if not often healthier. There can be no doubt that a patient suffering from cancer which, by its discharges or development, interferes with the important functions of life and undermines his powers, has an anxious, drawn, bloodless, and waxy appearance; but so has the subject of any organic disease which interferes with the functions of digestion and assimilation, and particularly the subject of intestinal disease. The patient exhausted by suppuration, by spinal, bone, or joint mischief, the man or woman who from drink, syphilis, or mercury (separately or combined) is gradually being brought down to death's door, has a cachexia more or less peculiar according to the organ involved in the disease and the special constitution of the patient; but it is merely the condition of looking ill. Clinically, I read the meaning of a cachexia as "looking ill," perhaps very ill, from some long-standing or slowly-acting cause; but it has no other definite signification than "looking ill" from cancer, "looking ill" from abdominal, rectal, suppurative, or syphilitic disease.

Points for Inquiry in Surgical Cases.

Disease or Injury. Date when seen. Result.

NAME, age, occupation, residence, general health, habits, and aspect. In some cases, hereditary history.

HISTORY OF PRESENT DISEASE OR INJURY.—Its assigned cause or method of production.

ORDER OF SUCCESSION OF SYMPTOMS, with their former treatment, and date of any marked change in either symptoms or treatment.

PRESENT CONDITION AND APPEARANCES, passing in review and noting when irregular the condition of intellect, senses, and nervous system. Organs of respiration and circulation. Pulse—frequency, force, volume, compressibility, distinctness, and rhythm. Temperature. Digestive Organs—tongue, appetite, bowels. Urino-genital Organs—urine, catamenia. Integuments—eruptions, moist or dry; above or below natural heat. Locomotive organs—bones, joints, and muscles; whether paralyzed or in undue action.

PREVIOUS DISEASES OR INJURIES, with their dates. Treatment.

PROGRESS OF THE CASE.—Note carefully any change in the old or the appearance of new symptoms, with the date of change and treatment, by medicine, diet, etc., etc. Carefully fill in the result, and date of departure; if unfavorable, the condition on post-mortem examination.

NOTE.—As the value of a report depends upon its conciseness, together with the accuracy and number of recorded observations, it is unnecessary to write one unless an appreciable change in the symptoms exists.

SPECIAL POINTS FOR OBSERVATION.

HERNIA.—Variety and character—its position, period of existence, assigned cause, and form; whether previously irreducible, and if a truss had been worn.

When STRANGULATED, give the symptoms, *general and local*, dating from the exact period of strangulation, the first appearance of sickness, character of vomit.

PREVIOUS AND PRESENT CONDITION.—If by *taxis*, state whether forcible, and how long applied, with or without chloroform; when by *operation*, if sac was opened or not—if opened, *why?* its contents and their appearances. On reduction, note the time from the first symptoms of strangulation; success, immediate and final.

WOUNDS.—Variety, position, extent, and depth; how and with what produced; *when on scalp*, if exposing bone. Complications—hæmorrhage, etc. Treatment and result—whether united by adhesion or granulation.

TETANUS.—Idiopathic or traumatic, partial or general; time of appearance after injury; position and condition of wound. Death—whether from spasm or exhaustion.

DISLOCATIONS.—Form and position; simple or compound; how and when produced; previous treatment.

SYMPTOMS, general appearance and position of the limb; mobility, pain, amount of injury to soft parts. Treatment—time after injury; by manipulation or extension; mode of application of extension, with its direction and duration; chloroform, additional means employed. Result, immediate and final.

FRACTURES.—Simple or compound, or comminuted; how and when produced; position and direction of the line of fracture; its tendency; amount of injury to vessels and soft parts; in *compound*,

note position and extent of wound; if produced by the primary force or broken bone, what vessels, nerves, or joints are involved. Constitutional symptoms

TREATMENT.—Sand bags, starch bandage, splints, form of splint applied; date of application. Note the date of any change of local or general treatment.

FRACTURED SKULL.—Position; kind of injury and direction of the force; if attended by hæmorrhage, its amount, and whether from nose, mouth, ear, or external wound. Give evidence, if any, of brain mischief.

IN SUSPECTED FRACTURED BASE.—Paralysis of facial nerve; flow of blood or serum from ear, with the time of its first appearance after the injury and its duration; condition of hearing; state of vision, and of pupils; presence of subconjunctival hæmorrhage. If complicated with internal injury, as *concussion, compression, etc.*, carefully report symptoms in their order of succession, and whether immediately following the injury or not; the duration and amount of unconsciousness, insensibility; paralysis, its position, motion, sensation, or both; condition of sphincters; character and number of pulse, respiration; condition of skin. Treatment, etc.

DISEASED BONE.—Part affected; duration; cause, as external injury, syphilis, mercury; extent; superficial or deep, partial or general; previous treatment, especially as regards operations.

PRESENT SYMPTOMS AND APPEARANCES.—Condition of dead bone or *sequestrum*, fixed or loose; number and position of openings, or *external cloacæ*, with the date of their first appearance.

TREATMENT.—If by operation, its immediate success.

DISEASES OF JOINTS.—Part affected; date of first discovery; assigned cause, as injury. Note the early symptoms in the order of their appearance, and date of any fresh symptom or marked change; if pain or uneasiness preceded swelling, or was coeval with it; if the former, how long? Rapidity of progress; previous treatment, and its effects.

PRESENT APPEARANCES.—Position of joint; if flexed, the angle of flexure; size and shape.

CHARACTER OF SWELLING.—Uniform or bulging; manipular indications, hard, soft, elastic, or fluctuating; mobility, amount; if attended with grating, etc.; in the knee-joint, note if the patella be free or not; if free, the sensation felt on moving it; condition of skin; if fistulous openings exist, their position, number, and character of their discharge; deep or superficial; note the date of their first appearance, and if natural or artificial. Pain, acute or gnawing; its position, general or local; if aggravated by motion or interarticular pressure; if increased at night. Sleep, if disturbed by crying or starting of the limb; sympathetic pain, and its position; condition of muscles of limb; constitutional symptoms. Treatment.

STRICTURE.—Organic or traumatic; duration and assigned cause, especially as regards gonorrhœa; use of injections, or accident; if previously treated by catheter; complications, as abscess, fistula, with their position and date of appearance.

RETENTION.—Mention period of retention; preceding symptoms, and cause, as stricture, calculus, paralysis, abscess, prostatic disease, etc. Constitutional and local symptoms; previous and present treatment; puncture per rectum, note the date of removal of the canula and arrest of the flow of urine through the wound.

EXTRAVASATION.—Cause, over-distension or accident; duration of retention before urethra gave way, and period that elapsed before being seen. Describe the appearances and extent of parts infiltrated; constitutional symptoms and treatment.

VENEREAL DISEASE.—Chancre, duration; position, glandular, urethral, coronal, or frænal—external, internal, or fringing preputial; character, indurated, non-indurated, aphthous, raised, excavated, irritable, phagedænic, or sloughing; tubercle; condition of inguinal glands, indurated or inflamed. *Previous treatment*, particularly as regards mercury.

COMPLICATIONS.—Note the date or appearance and situation of each or any of the complications; the order and time of their occurrence after the primary sore. Present appearance and treatment of each.

GONORRHŒA.—Date of contraction; former treatment, especially as regards injections, copaiba, etc. Complications, and their duration; in epididymitis, if following suppressed discharge; use of injections, copaiba, or violent exercise.

STONE IN BLADDER.—When discovered; date of earliest symptoms; if preceded by the passage of sand; amount of irritability of bladder; character of urine; constitutional and local symptoms. Treatment—lithotrity or lithotomy; in latter, note any peculiarity; date of arrest of the flow of urine through the wound.

TUMOR.—Date of its discovery and size; rapidity of growth; general and local symptoms, in their order of appearance. General health prior to discovery, and since; hereditary tendency; assigned cause; depressing influences. In mammary tumors, number of children; date of birth of last; if ever suckled with affected breast, when? condition of the catamenia; if ceased, how long? Previous treatment, and success.

PRESENT CONDITION AND APPEARANCES.—Position of tumor; size, shape; external aspect and condition of skin; pain, and its character; condition of lymphatic glands; manipular indications; mobility, when in breast, whether moved by traction of the nipple; feel hard, elastic, etc., etc. Constitutional symptoms.

TREATMENT.—In recurrent growths, give the date of former operations; date when healed, and of its first reappearance and position.

OPERATIONS.—Describe position, direction, and number of external incisions; the steps of the operation as performed; its duration; number of vessels tied or twisted, and amount of hæmorrhage. In amputations, the part amputated, and position of amputation. In flap operations, give the position of the flaps; whether anterior, posterior, or lateral; whether performed by perforation or external incision. In the combined flap and circular, note the position of the skin flaps; in all note the result and character of stump.

CHAPTER I.

ON WOUNDS, REPAIR, AND INFLAMMATION.

From a clinical point of view, wounds may be divided into the **Open** and the **Subcutaneous**, if we exclude those by which animal poisons are introduced into the system, such as dissection wounds, the stings of insects, bites of snakes and rabid animals, and the wounds which afford an entrance to the poison of glanders, malignant pustule, and last, but not least, syphilis. The term "*open*", is applied to all injuries caused by external violence—the result either of accident or, as in an operation, of design—in which there is a solution of continuity in the soft tissues, and in which the deeper parts are exposed to the influence of the air through a more or less gaping orifice. The term "*subcutaneous*" is applied to such injuries as follow external violence, in which the deeper tissues, bones, or viscera are broken, ruptured, lacerated, or crushed, without any breach in the continuity of the soft parts covering them, and consequently without their exposure to the influence of the external air, as well as to such operations as may be made by the surgeon through a small external or open wound, as in tenotomy, myotomy, and osteotomy.

"Open" wounds are more serious, as a rule, than the "subcutaneous," though the latter, when large vessels and viscera are concerned, are among the gravest injuries the surgeon has to deal with. Open wounds, moreover, heal by a more complicated process than the subcutaneous, and are exposed to risks from which the latter are free.

Classification of Open Wounds.

When made by a sharp-edged instrument, either by accident or in an operation, wounds are said to be *incised*; when inflicted by a blunt instrument that tears, they are called *lacerated*; and when caused by one that bruises, *contused*. Wounds caused by the thrust of a pointed instrument are called *punctured*, though when the weapon is sharp the tissues are simply pierced and cut deeply; but when blunt, irregular in shape, or increasing in diameter from the point toward the handle, the soft parts are forced asunder as by a wedge, and are consequently stretched and contused. A punctured wound under some circumstances approaches the character of the incised, and under other circumstances that of the contused, form of injury. As a matter of fact, however, nearly all wounds of soft parts are more or less contused, those inflicted with a very sharp instrument being, of course, the least so.

Simple or Complicated.—A wound is called "*simple*" when it has been made by a clean, sharp-edged instrument in a healthy subject, and when there is nothing in the nature of the wound itself or in the state of the patient to prevent or retard repair, provided that the injured part be placed in a favorable position for the reparative process to be carried out. The wound is called "*complicated*" when there are foreign bodies lodged in the part interfering with repair; when it is attended with hæmorrhage, with much contusion or laceration of tissue; or when from the peculiarity of the patient there are nervous symptoms, severe pain, constitutional disturbance, or local inflammation; or when repair is interfered with by the presence of such complications as bad health or old age.

Incised Wounds.

Open incised wounds are best seen as the result of operations, but they may also be well studied as clean cuts accidentally made with sharp-edged instruments. They may *gape* from the elasticity or contractility of the tissues divided, may *bleed* from the division or wound of small or large vessels, and may give rise to variable degrees of *pain* according to the number or character of the nerves involved, and according to the susceptibility of the patient.

The amount of "gaping" in a wound varies with the tissue divided. *Skin*, which is the most elastic tissue in the body, retracts when divided far more than other tissues, and transverse wounds of skin gape more than those which are longitudinal. *Arteries*, when wounded transversely or obliquely, gape much, and when completely divided across retract far into the tissues. Divided *veins* retract less than arteries. *Muscles*, when their

fibres are cut across, shorten rapidly by contraction, and thus aid the gaping of a wound. *Fibrous tissues* and nerves when divided retract but little. All wounds, however, which are made in parts in a state of tension gape much, and tissues which are on the stretch when divided retract far more than they would do if they were relaxed. Thus, an incision made into the full breast of a suckling woman will probably by gaping appear as wide as it is long; while one made into the same organ in a flaccid state would gape but little. Some tissues, on the other hand, never gape on division; this is best seen in wounds of the palm of the hand and of the sole of the foot.

The surgeon takes advantage of these known conditions of gaping and retraction of tissues, and in his operations so places on the stretch the parts to be divided as to enable him to make a clean and decisive section of the tissues with which he is dealing, a single sweep of the knife, made under these circumstances, doing the work of many when made under others less favorable.

Hæmorrhage from Incised Wounds.—The "bleeding" that attends an incised wound depends principally upon the size, number, and character of the vessels that are divided, although it may be influenced by the personal peculiarities of the patient, and more particularly by the fact of his being a "bleeder" or not; or, in other words, by his being or not being a subject of the "hæmorrhagic diathesis." The condition of the wounded part, moreover, whether inflamed or otherwise more than normally supplied with blood, has some influence, and the effects of position must always be taken into account.

Putting aside, however, those peculiarities, constitutional and local, the myriads of vessels that are divided in a wound made in a healthy subject with sound tissues rapidly, if not instantaneously, close on the removal of the dividing medium; for it is a fact that capillary bleeding after an incised wound rapidly ceases by natural processes. That which goes by the name of "hæmorrhage" is due to the issue of blood from wounded arteries of some size or from wounded veins, and the bleeding, if it does not prove rapidly fatal, persists till nature's hæmostatic processes—unassisted or assisted by art—have time to act.

Pain of Incised Wounds.—The "pain" attending an incised wound varies in its nature and degree according to the position of the wound and the tissue wounded. Some portions of the body, such as the skin of the face and fingers, the orifices of the mucous tracts, the periosteum, and tense tendons, are far more sensitive than the skin of the back and buttocks, the bones and the fasciæ. The sensibility of the patient has likewise much to do with the degree of pain experienced; so also has the condition of the nervous system at the time at which the wound is received. Not only may one subject of an operation be far more sensitive than another, but the same subject may feel pain more acutely at one time than at another, the general condition of the physical powers, and more particularly of the nervous system, greatly influencing sensibility. Unexpected or unseen wounds, or wounds received during drunkenness or when the mind is intent on other things, as in the excitement of battle, are often unfelt or felt but slightly; whereas when the mind of a patient is fixed upon the performance of an operation the evil influence of anticipation aggravates his suffering.

Local and Constitutional Effects of Incised Wounds.

The "local effects" of a simple incised wound on a healthy subject may extend little beyond the breach of surface and the slight pain and bleeding which attend the injury. The "constitutional effects" may be so slight as to be unobserved. In a general way, however, local as well as constitutional effects show themselves, and these are greatly influenced by the extent of the wound, the general condition of the patient, and the treatment to which the injured part and the patient have been subjected.

Local Effects.—These are best studied in a deep incised cut which has passed through skin, subcutaneous fat, and fascia.

The wound, directly after its infliction, will gape, and after the lapse of but a brief interval of time this gaping will increase so that the subcutaneous fat will appear as if it were being pressed out of its position, and as if the divided edge of the skin were retracting from it and becoming everted. Within an hour, or an hour and a half, the edges of the wound will be seen to be *swollen* and slightly *red*, from increased vascularity; and if the connective tissue of the wounded part is loose, as in the eyelid or male genital organs, it will be puffed up and œdematous. To the patient the part will feel hot and stiff, and it will be the seat of a dull, aching, or burning pain. The edges of the wound will also

probably be more sensitive, the amount of pain depending much upon the *tension* of the parts and upon the treatment to which they have been subjected. If the edges of the wound have been stitched together and the parts are much swollen and œdematous, there will be tension upon the wound and a disposition to separate and gape. In a healthy subject, however, when repair goes on well, all these local phenomena will subside and disappear in the course of two, three, or four days, according to the rapidity and perfection of the healing process, and a cure will then take place. But should the local phenomena above described be more persistent, increase in severity, spread beyond the margins of the wound and surrounding parts, or alter in character for the worse, what has been a physiological reparative process will pass into a pathological or diseased one, and the parts will then be said to be "inflamed."

Constitutional Effects.—The "constitutional phenomena" associated with these local changes vary greatly. In some subjects a trivial local injury, a mere cut, may give rise either to a more or less severe "shock" or to a disturbance of the nervous system which expresses itself in convulsions; whereas in other persons a severe and extensive wound may be followed by few, if any, constitutional symptoms.

"Shock."—The gradations of shock and collapse are innumerable, and the symptoms by which they are characterized vary from a passing faintness or disturbance of the heart's action to final syncope. The state of collapse may be regarded as a chronic syncope. Patients may unquestionably die from "shock" following slight injuries or minor operations, though no satisfactory cause for death may subsequently be discovered, the heart's action being suddenly stopped through some central nervous influence.

The degree of "shock" that attends an accident or operation depends, as a rule, upon the importance in the animal economy of the organ injured, the extent and nature of the violence which the tissues have sustained, the size of the blood-vessels which have been involved, and the amount of blood which has been lost. A patient in good health will bear a severe wound or operation with little shock; while another with diseased viscera, and more particularly with diseased kidneys, will be subjected to severe shock from even a trivial injury.

The age and constitutional condition of the patient have an important influence under all circumstances.

"Reaction."—When what has been described as the period of "shock" after an accidental or operative wound has passed away, the stage of "reaction" is reached; and in a general sense it may be assumed that the intensity of this stage is fairly governed by the intensity of that which preceded it—that is to say, where there has been little shock there will be but feeble reaction; and where the shock has been severe or prolonged the stage of reaction will be of a like type. Still, this rule has innumerable exceptions, and these exceptions seem to depend more on the individual peculiarities of the patient than anything else: one person, after a slight injury or operation, experiences little shock, but sharp reaction; while another, suffering from a severe injury or operation, will have a prolonged stage of shock, followed by no more reaction than seems to be necessary to restore the circulation to its normal condition, and to allow the functions of the body to work efficiently.

Children and women and the subjects of neurotic tendencies always react rapidly and in a marked way from all kinds of shock, whether mental or physical: but, as a rule, they do well. The rigors, nervous tremblings, and fears which are often met with in nervous subjects after operations, and which often cause alarm, are but rarely followed by any bad results.

The *symptoms of reaction*, in their mildest expression, are simply those of the restoration of the circulatory and nervous functions to their normal condition, the heart, with the circulation generally, so rallying from the depressed condition into which it has been thrown by the "shock" of the accident or operation as to come up to the usual standard of health, and the nervous system so recovering from the temporary state of depression, if not of unconsciousness, into which it has been cast as to resume its normal power of governing and controlling the actions of the body over which it presides. The reparative process, consequently, under these circumstances may be expected to go on uninterruptedly to a successful issue. The wound will undergo repair and heal, and the subject of the wound will suffer little or no constitutional evil beyond that occasioned directly by the injury. The stage of reaction in a clinical sense will then be normal: it will be such as may be said fairly to balance that of shock, and to tend toward recovery.

Traumatic Fever.—When the symptoms of reaction, either with respect to intensity or duration, exceed the normal standard; when the circulatory system acts power-

fully and rapidly, the respirations increase in quickness, the brain and special senses become abnormally active, and the temperature of the body rises and remains above that of health; and when with this elevation of temperature the functions of the body generally are disturbed and work badly, as indicated by thirst, a foul tongue, loss of appetite, constipation, diminished secretion of urine, want of sleep, or disturbed rest,—"traumatic fever" is said to exist.

This fever may show itself the day after the injury or operation or may not appear till the second day, and it may last for twenty-four, forty-eight, or seventy-two hours. When the case is going on satisfactorily toward recovery, the fever seldom lasts beyond this period. Should the symptoms, however, continue, dangers are to be apprehended and difficulties looked for. When the fever runs on into the fifth or sixth day, the surgeon may be sure that some complication is present; and should the symptoms be still more fixed, the probabilities are that the case is not only badly complicated, but that it will pass on to a fatal issue.

Temperature Chart.—Under all circumstances, and in the treatment of every wound, accidental or operative, the eye of the surgeon should be steadily fixed on the temperature chart, such a chart affording the surest indication of the advance or presence of any such complication.

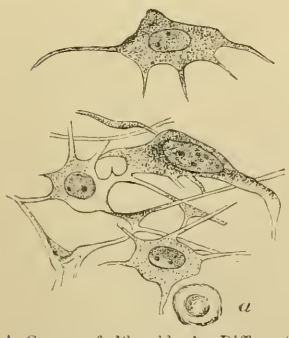
Process of Repair in Wounds.

Before entering into details, it is well to know, as a primary truth, that the processes of repair are identical in all tissues; that the reparative process in bone or muscle, integument or tendon, soft or hard parts, is the same, such modifications alone showing themselves as necessarily appertain to the anatomy of the tissue or to the special circumstance of its position. Thus, tissues that are highly vascular may undergo more rapid and more perfect repair than others less fortunately circumstanced, and bone tissue may require more time to unite than skin; yet in all the process is alike. Let us, therefore, inquire what the process is, and see what changes take place in parts undergoing repair, and then look at them where they are best seen—where an incision is made through the skin and the edges are brought together.

The chief points that can be observed have reference to the capillaries. In them, at the margin of the wound, the blood will be found coagulated up to the nearest anastomosis, and the capillary vessels in the neighborhood will be seen to be dilated. This dilatation is caused by the increase of pressure to which the capillaries have been subjected by the altered circulation of the blood in the immediate vicinity of the wound. When wounds unite by *immediate union*, no other changes than these take place, beyond the gradual restoration of the capillary circulation through the parts that have been divided; and under such somewhat rare circumstances no scar or cicatrix is left. The soft parts at first simply adhere together, and subsequently become continuous.

Adhesive Lesion.—Should the wound unite by what is called *adhesive union* or *primary adhesion* (the "first intention" of John Hunter), in which a cicatrix is formed, other changes are to be seen; and these take place in the connective tissue, in which the vessels of the part ramify. They consist of cell multiplication, and under the circumstances supposed we find between the edges of the wound a vast accumulation of cells, filling up in various degrees the spaces of this wounded tissue. It is through these cells that cicatrization takes place. The cells are in part simple nucleated cells, which may be called "embryo cells" with connective-tissue corpuscles, and they contain a nucleus and nucleoli, Klein's placoid cells (*vide* Fig. 1).

Fig. 1.



A Group of Placoids in Different Stages of Growth: *a*, Embryo cell wandering. (*After Golding Bird.*)

Whether this cell multiplication depends upon changes in the cell itself, as Virchow affirms, or whether the cells are the white corpuscles of the blood which have escaped by exudation from the capillaries, as Cohnheim would lead us to believe, I do not now care to inquire. All admit, however, the multiplication of cells in the affected tissues (*vide* Fig. 2). Professor Redfern writes, "The facts must be recognized: the floating blood cells are really the very cells which once formed the substance of the lymphatic glands, the spleen, and other organs, and they do in fact move through the walls of the blood passages and wander about freely in what are called solid tissues." When

we recollect how penetrable the tissues of an animal are, we shall cease to be startled at seeing them become the seat of entirely new deposits, or finding them traversed by migrating blood corpuscles as freely as a colloid is penetrated by a crystalloid

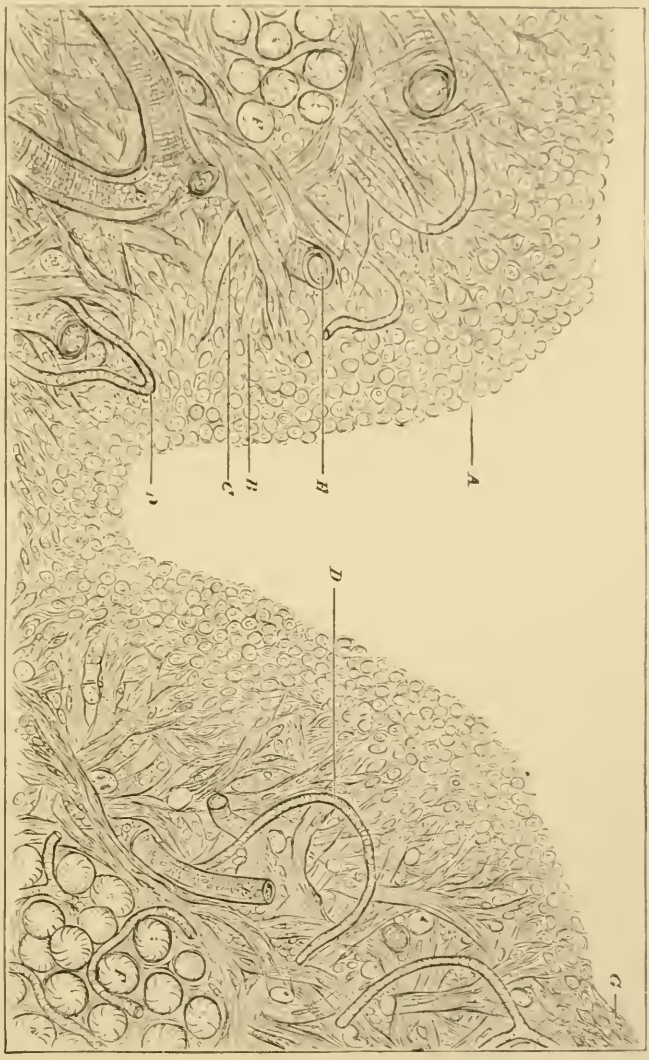


FIG. 2.

DIAGRAM ILLUSTRATING THE PROCESS OF REPAIR IN A WOUND FILLING UP BY GRANULATION.

A Granulation cells with single or double nuclei. These, when shed, are pus cells. *B.* The same cells becoming spindle-shaped. *C.* Intercellular element becoming developed into bundles of white fibrous tissue. *D.* Capillaries. *E.* Small arteries. *F.* Fat vesicles forming lobules. The last two structures constitute part of the original subcutaneous tissue. *G.* Superficial cells becoming converted into epidermal scales.

(This drawing has been made for me by my friend, Mr. Howse, from microscopical sections of granulations in his possession.)

Cicatrization.—Let us now inquire briefly how cicatrization proceeds, and note that it is in the cells that the most important changes are to be recognized. Those nearest the injured part gradually assume a spindle shape, and the intercellular tissue into which these spindle-shaped cells are infiltrated becomes denser. The spindle-shaped cells then gradually change into ordinary connective-tissue corpuscles, and in this way new cicatrical tissue is formed. This new tissue, however, again undergoes changes—changes of consolidation. The intercellular tissue becomes gradually more condensed, and the spindle-shaped cells assume the flat shape of connective-tissue corpuscles and in a measure disappear, the nucleus alone often remaining. The fluid that existed in the newly-formed tissue is absorbed, and the new cicatrix by degrees becomes firmer and denser, gradually contracting; so that at last the delicate scar of a large wound becomes solid and compact. The cicatrix in smaller wounds appears only as a thin red, and at a later period as a white, line.

Changes in the capillaries of the part are, however, going on during all this period, but how far *all* the changes that have been briefly described are due directly to the capil-

lary action is not yet determined. If Cohnheim's views be adopted, it is to the capillaries that the chief action in the tissues must be ascribed; but if those of other pathologists, such as Virchow and Billroth, be accepted, the capillary action takes a secondary place and the cell elements take the leading one. On either theory the importance of the capillaries cannot be overlooked

With regard to the changes in the capillaries, it has been already pointed out that at the beginning of the reparative process the capillaries of the part become sealed and the collateral circulation in the neighborhood becomes irregular and pressed upon, and that the coagula in these obliterated capillaries become reabsorbed, or possibly reorganized, as repair progresses, since it is certain that the capillary network soon becomes continuous through the newly-formed cicatricial tissue, and that the capillary meshes of the one side join, by loops projected through the new tissue, similar meshes of the opposite one.

What influence the nerves of the part have upon the reparative process we do not know. That they have an important influence there can be little doubt, since all physiologists recognize their power upon secretion and nutrition; the vaso-motor nerves doubtless have the greater power. But we must learn something more of nerve power generally and nerve distribution—something of the way in which the nerves terminate in the tissues, and what relation they bear to the capillaries—before we can hope to find out or understand the exact influence nerve supply has on repair.

Repair by Granulation.—All wounds do not, however, heal by immediate union or by primary adhesion—*i. e.*, first intention; and wounds that gape cannot so unite. The process of repair in them differs, therefore, somewhat in its character from the process in those which we have been considering: it *takes place by granulation*, or the "second intention of Hunter." If we closely examine the surface of a wound thus exposed, we shall find that it becomes, within a few hours of its exposure, covered with a film of a peculiar gelatinous, grayish-white appearance, which will be seen, with the aid of the microscope, to be composed of granulation cells or white blood cells, "Hunter's plastic lymph." After an interval of some hours the parts covered with this gelatinous grayish film become more vascular, as indicated by redness, and the surface more even. The film itself assumes a tougher character, and a yellow fluid, which is mixed with small yellow sloughs of fibrinous tissue, is secreted. The wound begins "to clean," and to have a smooth and consistent surface. After the lapse of another day, or some days, perhaps, this surface is covered with a number of elevations, known by the name of *granulations*, varying in size from a millet-seed to a hemp-seed, the smaller being highly vascular and red, the larger being, as a rule, paler and more bloodless. The wound at this time is "granulating," and the secretion from it is now of a creamy-yellow character, and is called *pus*. The granulations are made up of cells called granulation cells, which resemble inflammatory lymph cells, and each granulation contains a vessel the walls of which consist of a thin membrane in which nuclei are embedded. "Some of these nuclei are arranged longitudinally, others transversely, to the axis of the vessels. In the development of these vessels changes occur answering to those seen in ordinary embryonic development. Organization makes some progress before ever blood comes to the very substance of the growing part, for the form of cells may be assumed before the granulations become vascular. But for their continuous active growth and development fresh material from blood, and that brought close to them, is essential. For this the blood vessels are formed, and their size and number appear always proportionate to the volume and rapidity of life of the granulations. No instance would show the relation of blood to an actively growing or developing part better than it is shown in one of the vascular loops of a granulation embedded among the crowd of living cells and maintaining their continual mutations. Nor is it in any case plainer than in that of granulations that the supply of food in a part is proportionate to the activity of its changes, and not to its mere structural development. The vascular loops lie embedded among the simplest primary cells, or, when granulations degenerate, among structures of yet lower organization; and as the structures are developed and connective tissue formed, so the blood vessels become less numerous, till the whole of the new material assumes the paleness and low vascularity of a common scar" (Paget).

Formation of New Skin.—If, at this time, when the granulations have attained to the level of the skin, we look to the margins of the wound, we shall see a dry red band of newly-formed tissue, with an outer border of a bluish-white color where it comes into contact with sound integument. This band is the new skin forming, and is caused by the gradual growth of the epidermis from the margin of the sound skin toward the centre of the sore. Such a process is called "*cicatrization*." The cicatrix is at first red,

as in the linear cicatrix, to which we have already alluded, but as it contracts it subsequently becomes paler, more compact, and adherent. The nature of the scar or cicatrix varies with the tissue in which it is formed, the new connecting medium under all circumstances having a powerful tendency to approach the peculiar character of the tissue in which it is placed. Thus, a cicatrix in the skin in time closely resembles true skin; a cicatrix in bone, true bone; and a cicatrix in tendon becomes tough and hard like tendon. Under all circumstances the consolidating reparative material partakes of the character of the parts which it connects.

Secondary Adhesion.—When two granulating surfaces are brought together and union takes place between them, *healing by "secondary adhesion,"* or by *the "third intention,"* is said to occur. The process of repair, under these circumstances, is similar to that of immediate or adhesive union, the two layers of granulations adhering, either directly or by means of some new material, as two surfaces of divided tissue. The capillaries and embryo cells, under both circumstances, undergo changes such as have been described. For this form of union to take place, the granulations, however, must be healthy.

Scabbing.—When wounds *heal "by scabbing,"* granulations do not form. In this process the reparative material which is poured out undergoes at once similar changes to those already described as taking place in adhesive union, and the wound cicatrizes rapidly beneath the scab; for the serum of the blood, when effused on the surface of a wound, is of a highly plastic character, and quickly coagulates to form a film of a protective nature, under which repair may rapidly proceed, the embryo cells, with this—Hunter's "plastic lymph"—being the medium of repair. The treatment of superficial wounds is based upon the knowledge of this process, and the value of felt, cotton-wool, or any similar material, when applied to an open wound, entirely depends upon this plastic property of serum. Repair by scabbing is doubtless the best form of healing, although it is, unfortunately, somewhat rarely obtained.

The **Nature of the Healing Process** is physiological, and resembles closely that of development and growth. The changes in the cell-elements which have been described in repair, and the gradual development of the most elementary tissue into cicatricial tissue or higher structures of the human body, are similar in nature, if not in form, to those which are witnessed in the embryo when the blastoderm cells, or primary nucleated mass of protoplasm, in the ovum, grow, develop, and differentiate into the various structures of the human animal.

For the healing processes there must be a sufficient blood supply for nourishment, and there must likewise be a regulating force to control and direct the formative process; and this force doubtless comes from the nerves.

When the vascular supply is deficient, growth or development must suffer and the physiological process of repair cannot go on; when the vascular supply is in excess, what would have been a physiological becomes a pathological process, and the part undergoing repair after injury is said to be "inflamed." The process of *construction*, under these circumstances, ceases, and that of *destruction* may ensue; or there may be changes in the now inflamed but formerly repairing wound or granulating surface, which will be considered under the heading of "Diseases of Granulations." What I would now impress upon the reader is that whatever action is required for the healing process is physiological, and is just equal to its purpose; when it is excessive, it becomes pathological, and is known as "inflammation." Inflammation, when it attacks a wound, at first checks repair, and later on brings about disorganizing changes; inflammation, under all circumstances, has a destructive tendency.

Regeneration of Tissues.—It has already been pointed out that the processes of repair are identical in all tissues, that the reparative process in bone or muscle, integument or tendon, capillary or nerve, is the same, such modifications alone showing themselves as necessarily appertain to the histology of the tissues; and it is well that this physiological truth should be fully recognized. At the same time, it is to be equally recognized that all tissues are not formed out of cicatricial or connective tissue, but that the higher forms of structures, such as muscle, nerve, bone, etc., are repaired by the regenerating influence of the injured tissue itself, new cells springing or growing by a kind of budding process from the divided ends of the injured part, the new cells in contact with or poured out by the injured tissue, whether as embryo cells, connective-tissue cells, nerve cells, muscle cells, or bone cells, being so influenced by the tissue with which they are in contact, and from which they probably originated, that they anatomically partake of its nature and bring about its repair.

Repair of Muscle.—When *muscular tissue* is wounded or more or less destroyed, O. Weber tells us that it may be restored, and that the young muscular fibres are formed out of the old by the division of the protoplasmic material of their extremities, the repair of muscle being thus brought about by agencies closely simulating those of fœtal development. Gussenbauer gives a drawing of the process. Billroth, however, asserts strongly that he has never seen anything which he could regard as a re-formation of muscular fibres, and that the cicatrix in muscle is almost entirely connective tissue,[1] the extremities of the muscular fibres, after division and repair, uniting with the cicatricial tissue in the same way as they do with the tendons. My own observations go to confirm those of Billroth.

Repair of Nerves.—There is good reason to believe that an injured, or even a divided, nerve may be thoroughly repaired, since conclusive evidence has in recent times been adduced to prove that such a large trunk as the median, the ulnar, or the great sciatic may be divided, and subsequently so joined by surgical skill as to secure, after the lapse of a certain interval of time, perfect union of the divided ends, as proved by the complete restoration of the functions of the nerve in their physiological perfection.[2]

It is likewise true that new cicatricial tissues become sensitive, and that parts which by accident or operation have been deprived of the influence of one nerve regain their sensibility, either by the growth of new nerves, or by the assumption on the part of another branch of the same nerve or of another nerve of the physiological functions of the one that has been destroyed.

From these facts the conclusion is clear that nerve tissue must be regenerated, and that the divided ends of nerve must reunite by new nerve material. It seems, moreover, highly probable that new nerves may develop. In a physiological point of view, these facts are not only very remarkable, but they tend to demonstrate the perfection of the reparative process, since, to allow of the conduction of nerve force to and from the nerve centres, very powerful conductors are unquestionably required.

The process by which this repair is brought about has been carefully studied by Schiff, Hjelt, and others, and is much after the following fashion, as given by Billroth:[3] "There is first of all a degeneration of the medullary sheath, possibly also of the axis-cylinder, for a certain distance from the injury, which is quickly followed by the production of cells in the neurilemma; these develop into spindle cells, and spread into the tissue which intervenes between the nerve fibrils, and which extends also between the cut extremities of the nerves. From these cells, as in the embryo, nerve fibres are developed, and these nerve fibres ultimately cannot be distinguished from ordinary nerve fibres."

Sources of Interference with Healing of Wounds.

The different modes of healing, and the processes by which injured tissues are repaired, having been fully described, I propose to consider the causes that interfere with, retard, or prevent repair; and these may be found either in the "*wound itself*," in the "*subject of the wound*," or in "*its treatment*."

Local Causes.—Among the causes which exist in the wound itself, the *presence of any foreign matter* whatever must be placed first, since it is clear that where such is found, even to a limited extent, repair by immediate, primary, or quick union is impossible. The foreign matter not only by its presence mechanically prevents the adhesion of the surfaces between which it is placed, but also acts as an irritant or as a promoter of septic changes, and thus excites an action in the wound which is not reparative, but inflammatory. The truth of this general rule is not disproved by the fact that in exceptional cases foreign bodies become encysted in tissues and give rise to but little trouble.

The *occurrence or persistence of bleeding* in the wound is a second local cause of non-repair, the reparative process not commencing until all bleeding, even capillary oozing, has been arrested. When the hæmorrhage is great, this interference may be serious; and even when little, it is enough to retard and prevent the reparative process from being carried out. Blood, if effused to any extent between the sides of a wound, interferes with the reparative process much in the same way as does a foreign body, and forbids all healing by quick or primary adhesion. If effused in very small quantities between the divided surfaces, it may at times possibly change into cicatricial tissue and form a band of union between the divided parts, and under these conditions it may become organized,

[1] Syd. Soc., Billroth, *Surg. Path.*, vol. i. s. 151.

[2] *Vide* Dr. Weir Mitchell in the *American Journal of Med. Science* for April, 1876; *Clinical Society's Trans.*, vol. xii.

[3] Billroth, vol. i. p. 152.

as when poured out on the brain; but, as a rule, the effusion of much blood into a wounded part is a retarder of repair or a cause of non-repair.

When a wound has to heal by granulation, a clot of blood, as a covering, kept aseptic, is beneficial, since it acts as a protector to the surface of the wound and allows the granulating process to go on uninterruptedly. It has been said that such clots become organized, but it is far more probable that they simply act, as above described, as a protection to surfaces that are granulating.

A *contused or lacerated* surface in a wound is a third local cause of non-repair, and it is well to recognize this important fact, since, with such a condition of parts, the surgeon knows that immediate or primary union of the wound is not to be expected. Under these circumstances a line of treatment will be indicated which will be far more likely to be efficient than one based on the hope of obtaining quick repair. When the contusion or laceration is slight, the hope of securing primary union of the divided parts may, indeed, be entertained; but when it is great, such a hope would be altogether groundless. The gradations of contusion and laceration between these two extremes are numberless; but it will be wiser for the surgeon to believe, and upon such a belief to act, that in contused and lacerated wounds the prospect of obtaining quick union is slight, than for him to act upon an opposite view, and attempt to obtain, in severe cases, a mode of healing the occurrence of which is improbable if not impossible.

In a contused or lacerated wound the surgeon should mentally see dying or dead matter which of necessity must be separated from the living parts and got rid of, either by molecular disintegration or by a coarser sloughing process, before the act of healing can rightly be said to begin, and under these circumstances he will at once recognize the futility of entertaining a hope of obtaining the repair of the wound by quick union.

Constitutional Causes.—Of the causes of non-repair which are to be put down to the account of the subject of the wound, "*age*" is all-important, the reparative process in a man the wrong side of fifty being conducted with less vigor than in one who is on the right. In the very old repair is at its lowest mark. The same remarks are applicable to patients who are the subject of "*organic disease*" or of *degenerative changes* in their tissues, and especially to fat and soft-tissued people, the old in years or in infirmities not possessing the recuperative powers of the young and vigorous. Under these circumstances, in the case of a wound resulting from accident or operation in a patient over fifty years of age or in one in ill-health, it would be wrong for a surgeon to expect or to rely upon securing a mode of repair which in a younger or healthier subject he might reasonably look for. People who are advanced in years or who are feeble from frailty or disease, particularly visceral disease, have no, or an insufficient, capital at the bank of health to draw upon. Of all subjects for wounds, whether accidental or operative, the habitual drunkard is the worst.

Defects in Treatment.—Of the causes of non-repair which are to be attributed to treatment, a want of due care in maintaining the injured or wounded part in a state of rest claims the first place; for in such a delicate process as is that of repair it is plain that in any movement of the injured part, whether in the way of separation of surfaces or by manipulation, the process may be interfered with or retarded or the work already accomplished may be undone. It is certain that the best and most rapid repair of an injured part takes place when the wounded tissue is kept in an absolutely immovable position, and when the wounded surface is protected from all external influences that can possibly interfere with the physiological reparative process. It therefore clearly behooves the surgeon to have this great truth always before him, in order that he may adapt his treatment to the requirements of the case, and not have to blame himself for a want of care in maintaining that absolute immobility of the wounded or cut part which is essential for rapid, or even good, repair.

In the treatment of fractures the evil effects of want of rest and immobility of the broken bones are well exemplified, but it is to be remembered that the same want of rest and immobility is as pernicious in wounds of the soft as in those of the hard parts—in wounds of the surface as in those of the deeper structures. The term "want of rest" is here used in its fullest sense, as want of that thorough immobility of tissue and non-interference which are all-important for the rapid perfection of the physiological reparative process.

Gaping of Wound.—Again, if the edges of a wound are allowed either to gape or to have too much tension upon them, repair will be interfered with, the parts in both cases, from either want of care in their adaptation or want of caution in not making due

provision for the escape of the redundant fluids (drainage), or from some over-action (inflammation), not being allowed to remain at rest and undergo repair.

Over-action in the vessels of a part which is undergoing repair—that is, inflammation—always has an evil influence. When it shows itself early in the case, it prevents repair; and when manifested at a later period, it retards the healing process, or even causes its retrogression. Indeed, under all circumstances when the vascular action of a part which is undergoing repair exceeds what is essential for the steady perfection of the process, the repair of that part is interfered with. Inflammation, when it attacks a wound, at first checks repair, subsequently undoes it, and at a still later period brings about disorganizing changes; under all circumstances it has a destructive tendency.

The student, having learned how wounded parts heal by nature's processes, and more particularly how simple incised and open wounds are repaired—and having, moreover, learned to recognize some of the most important influences which retard, if they do not arrest, repair—will readily understand the more favorable conditions under which repair can be carried out, and, what is more, will at once appreciate the surgical requirements of the case he may have to treat, so that, as a surgeon, he may know when and where to apply his art, how he can help nature in her beneficent action, and how he can best guard against the intrusion of any outside influences that may tell against the steady progress of the reparative process. For it cannot be too strongly asserted that the best surgeon is the one who best understands natural processes in the repair of parts and who knows how to use them to the greatest advantage, who recognizes the fact that these natural processes are exact and when applied to the healing of wounds undeviating; who knows that if he is to utilize these natural processes to the full he must bring up his art of curing to nature's line, under the conviction that nature never systematically bends herself or puts forth her hand to help the curer, that she never deviates from her path—that if, using Dr. Richardson's words, "we do not molest her she goes on, as we say, naturally toward a cure; if we molest her a very little, she goes on, and the molestation is but little shown; if we molest her vehemently, she still goes on, showing molestation in proportion to disturbance, nature under all circumstances going her own way, caring just as little for ease as for pain, for life as for death." When a bone is broken, nature will heal it quite irrespectively of the position in which it is placed; when a knuckle of bowel is strangulated, nature will cast it off quite regardless of the effects of such a sloughing act. But the surgeon who knows this knows, moreover, that the same natural process will work on when the bone is "set" in a right position and maintained there by art, and that the sloughing may be avoided when the strangulated bowel is relieved by art from its false position and placed where it can be best repaired by nature's means.

Treatment of Wounds.

In the treatment of a *simple* cut or incised wound in which there is no dirt or foreign matter to keep the edges of the wound asunder and to act as an irritant, in which there is no hæmorrhage beyond capillary or venous bleedings, which can be arrested by elevation of the part, moderate pressure, or the application of a cold or hot sponge, the surgeon has simply to cleanse the wound, bring its edges carefully together, and adopt means to keep them so; while at the same time he makes such provision for the protection of the wound as may secure it from injury from without or within, and may allow the reparative process which has been described as taking place in primary union to be quietly perfected.

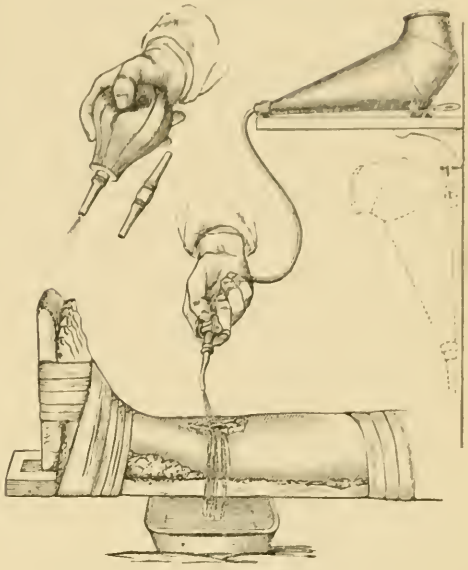
In *more severe wounds* a similar practice is to be advocated, though some care may be called for in cleansing the wound, more caution required in the arrest of bleeding, and more ingenuity demanded in bringing the edges of the wound together, as well as in so fixing the injured part in position that the patient may be comfortable, while the wound is kept immobile and protected from such injurious outside influences as would interfere with the healing act. Provision, moreover, will have to be made for efficient drainage—that is, for the free exit of such sanguineous or serous fluids as are commonly exuded after severe wounds or operations, and the retention of which always proves injurious.

Upon each and all of these points, therefore, a few lines may not be without value.

On Cleansing Wounds.—After full examination of a wounded part, and careful consideration as to the mode of its production, the extent of injury, and the requirements of the case for cure, the wound should be cleansed. This should be effected with all completeness and gentleness, since, on the one hand, everything like a foreign body between the lips of a wound would of necessity prevent quick or primary union, and

would in all probability prove injurious to the subsequent progress of the case; while, on the other hand, anything like roughness would be detrimental to the already injured tissues. To effect this cleansing with gentleness, a stream of water medicated with some antiseptic is the best means for the surgeon to employ, and this stream may be brought to bear upon the part by using the irrigating-bottle or the irrigating-can (Fig. 3) I have here figured. The stream of fluid washes away blood with all light foreign matter, and what cannot be washed away may be removed with fingers or forceps. In gunshot wounds special forceps and other instruments may be required.

Fig. 3.



Irrigating-Bottle and Apparatus.

Those who believe atmospheric germs to be the chief cause of inflammation and suppuration, or of most, if not all, the ills to which wounded flesh is heir, will employ the means that are supposed to be capable of destroying such malignant foreign visitors, and for this purpose will use the spray of carbolic acid, one part in forty, or other antiseptic, to kill the germs in the air as they approach the wound, and will dress the wound with the carbolic lotion, carbolic gauze, protective, and waterproofing, according to directions laid down in a future page (*vide* Listerian method of dressing wounds); whereas those who disregard atmospheric germs, and yet highly value means for purifying wound surfaces, will use antiseptic irrigation of the wound with a lotion of carbolic acid 1 to 20, of thymol 1 to 1000, of chloride of zinc 20 grains to the ounce (originally used by Mr. C. de Morgan many years ago), or of iodine, made by adding 10 drops of the liquor iodi to the ounce of water. I have employed the iodine lotion for years, and prefer it to any other. It is always at hand, and is both simple and effectual as a wound cleanser. The lotion may be used warm, and it has the advantage of not only cleansing the wound in the fullest sense of the term—for iodine is an antiseptic—but it has a marked tendency to arrest all capillary bleeding or oozing. I use it in about the proportions given above, but the best practical guide is to pour the solution or tincture into a basinful of water, so as to make the latter of a light sherry color.

Arrest of Bleeding.—It is well that hæmorrhage should be effectually arrested by some of the various means which the surgeon has at his command before the edges of a wound are brought together, and it is wise to have even capillary bleeding stopped, when it is possible; for blood effused in even limited quantities between the surfaces of an incised wound is to be regarded much in the light of a foreign body, and as forming an obstacle to repair, more particularly when primary union of the wound is to be sought for. Indeed, it was on this account that I was first led to employ, for cleansing wounds, the iodine water to which I have drawn attention, and which I cannot too strongly recommend for general adoption. A sponge wrung out of this lotion (made with hot water), and held to a wound for a minute, completely checks all oozing of blood, and tends more than anything else, except prolonged exposure to the atmosphere, to the formation of that glaze upon the surface of the wound which so much conduces to satisfactory repair.

On the Question of Repair by Primary or Secondary Adhesion.

When the surgeon has cleansed the wound, removed what foreign bodies may have been present, and stopped all bleeding, he has to decide upon the means whereby the reparative process may be best helped, and as a primary point to determine either the feasibility or expediency of attempting to obtain *quick* or *primary union* of the cut parts, or the wisdom of looking to their repair by the slower *open, granulating* process.

When the wound is of the *incised* kind, the question is not difficult to answer; for it may with confidence be asserted that, with few exceptions, in all wounds of this description, whether superficial or deep, accidental or the result of operation, repair by quick or

primary union is to be desired, and, what is more, may be expected if the subject of the wound be healthy and not too old, and if nature's reparative process be so aided by surgical art as to be allowed to take its course without interference.

The cleaner the cut is, the greater is the probability of its uniting by quick repair; the more ragged, contused, and lacerated the margins of the wound are, the less are the prospects of obtaining primary union and the less the wisdom of making the attempt. Between these two extremes are innumerable gradations. Where there is a doubt about the wisdom of making the attempt to secure primary union in deep, contused, and lacerated wounds, let the decision be against it; and when the doubt applies to the more superficial or hopeful class of wounds, let it be decided in its favor. Care must, however, be taken in these as in all cases to give up the attempt on the appearance of the slightest local or constitutional symptoms. It is also necessary to bear in mind that by drawing together the parts by sutures, etc., some retained blood, serum, or sloughing tissue may keep them in a state of *unrest*, either by tending to separate the lips of the wound and exciting tension, or by undergoing chemical changes and decomposition and thus favoring the production of some septicæmic or pyæmic conditions. For it must be recognized that whilst in the cleanest incised wound there *may* be no death of the divided tissues, and consequently no animal matter to undergo chemical changes or putrefactive decomposition, in the contused and lacerated there *must* of necessity be more or less.

When tissue dies, it must be shed or cast off from the living parts before the physiological reparative or uniting process can take its course. When this dead tissue has been separated from the living, it ceases at once to be influenced by the vital processes by which it had been built up, kept clean, and eventually cast off; it consequently becomes subject to the physical laws of all dead matter, and undergoes chemical changes—which means too often decomposition.

The object of the surgeon, therefore, in the treatment of these cases of wound in which the death of tissue is to be expected, and cannot be prevented, is to neutralize as far as possible the evil influence of its death and probable decomposition. This is to be achieved by so dealing with the injured part that the dead tissue may find a free outlet for its discharge, and by rejecting all such applications or dressings as are likely to help putrefactive decomposition, at the same time employing means and agents likely to neutralize its pernicious influence and to control, in a measure, the process of decay.

Treatment to Help Quick or Primary Union.

To promote the primary union of a wound, the surgeon has six cardinal indications to follow:

1. To cleanse the wound.
2. To arrest all bleeding.
3. To effect coaptation of the two divided surfaces of the wound, the deep parts as well as the edges.
4. To maintain the wounded parts in a position of immobility beneficial to the natural process of repair as well as comfortable to the patient.
5. To secure drainage of the wound by providing for the escape of such dead tissue as may be thrown off, as well as of all fluids that are not required for repair.
6. To protect the external wound from all such outside influences as may be prejudicial.

The first two indications have been already considered—viz., the cleansing of the wound and the arrest of bleeding (pp. 32, 33). In all forms of wound, and for every form of healing, attention to these points is most important; but when quick or primary union is to be expected, it is all-essential.

Third Indication: The Coaptation of the Edges and Surfaces of a Wound.

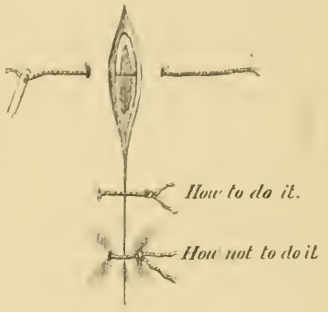
The coaptation of the two divided surfaces of the wound may be efficiently carried out in superficial or not deep wounds by means of sutures and adhesive plaster, separately or combined. When, by the use of trustworthy adhesive plaster, the object sought for can be obtained, sutures are not called for; and when sutures are used, the form of suture that carries out the object in view in the simplest way is the best.

Interrupted Suture.—When the wound is *superficial*, the sutures need not be introduced deeply; but when the wound is *deep*, the practice of bringing the edges of

the wound, and not the deeper parts, together is fraught with danger, since the repair by primary union which is looked for cannot take place, and between the separated surfaces of the deeper parts of the wound blood, serum, or inflammatory fluids will collect and give rise to trouble. Hence in deep wounds the sutures should either be all introduced deeply or deep as well as superficial sutures should be employed.

The *interrupted* (Fig. 4) is the most useful form of suture, and it is applicable to *superficial* as well as to deep wounds. It can be made with a curved or straight needle, according to convenience, armed with a single thread of well-waxed silk, wire, or fishing-gut, the fine silk line sold by tackle-makers being the best for ordinary purposes. The needle should be introduced through one side of the wound obliquely from without inward, and made to pass through the opposite side in the reverse direction from within outward. The knot of the suture should be brought to one side of the wound, as shown in fig. 4. In the *superficial* it should be inserted with sufficient depth and closeness to bring the surfaces and edges of the part accurately and closely together, and it should be tied with enough force to carry out these objects, but not with more, since to tie a suture as a surgeon would a ligature is to do harm, as the suture would cut rapidly through the strangulated tissues, and in so doing irritate the part instead of helping repair.

Fig. 4.



The Interrupted Suture.

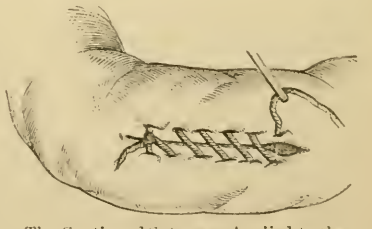
In *deep* wounds the sutures must be inserted deeply, as in hare-lip operations, and introduced well away from the edges of the separated tissues, so that when they are tightened the deeper parts as well as the superficial will be brought effectually into apposition. In some cases deep and superficial sutures may be made to alternate. Superficial sutures should include neither muscles nor deep fascia.

A double-reef knot is usually employed, but a "granny" (Fig. 137) is by no means a bad one to make, since it is a slip-knot and can be tightened at pleasure by a third tie.

In the majority of cases in which sutures are employed it is an excellent plan to alternate the sutures with strapping; a narrow band of the latter carefully adjusted between the stitches not only materially aids the adaptation of the edges of the wound, but, if well applied, tends to prevent tension and to immobilize the wounded structure, while at the same time it acts in the way of affording local pressure to the deeper parts of the wound. In operations on the breast the advantages of this practice are well exemplified.

Continued Suture.—The uninterrupted, continued, or Glover's suture (Fig. 5), the stitch of the sempstress, is valuable in all cases in which a very close and accurate adaptation of the margins of the wound is wanted, as in wound of the intestine, as well as in those of the eyelids and face generally; indeed, a clean wound of these parts, superficial or deep, may be so accurately and well adjusted by means of a fine needle and thread as to leave but a minimum of scar. In operations about the lip the same remark is applicable, although in these care should be observed to introduce the sutures deeply and well away from the margins of the wound. In operations for phymosis in the adult this form of suture is likewise of great value, as it not only expedites recovery, but does much to make the result of the operation more artistic. In these cases the fine carbolized gut suture may be used. The stitches should be removed on the third or fourth day. They may often be taken out of the face on the second. If left in long, they are apt to set up irritation and ulceration.

Fig. 5.

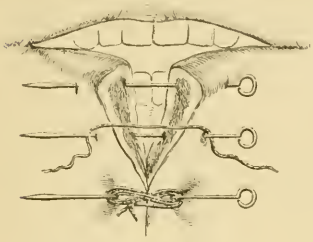


The Continued Suture as Applied to the Intestine.

Twisted Suture.—The twisted suture (Fig. 6) is of value in certain operations on the lips and cheeks, and in other parts where difficulty is experienced in bringing the parts together, since by its use more force can be brought to bear upon the margins of the wound, and their adaptation can thus be rendered more perfect. This form of suture was in former times the one commonly employed in hare-lip operations, but it is not so now. I have for years discarded it in favor of the interrupted suture of silkworm gut, or wire, and employ it only in cases in which exceptional difficulty is experienced in

bringing the parts together. It is useful, however, in cheiloplastic operations, as well as in the Pirogoff and Chopart's amputations. To apply it, some fine pins with flat heads, silk, and cutting pliers are wanted. The pins are employed to bring the surfaces of the wound in contact, and their points should be introduced half an inch or more from the margin of the wound, and passed deeply and obliquely, in lip operations, through the thickness of the tissues down to, but not through, the lining mucous membrane (Fig. 6). They should then be made to pass through the opposite side and brought out through the skin at a corresponding point. A piece of silk passed as a figure-of-8 should be twisted around the two ends. The wound may next be drawn together; and should the apposition of the surfaces be imperfect, the pins should be taken out and the parts be readjusted, and in this lies the great advantage of this form of suture. After the silk has been tied in knots and the ends cut off, the points of the pins should be removed and the soft parts protected from the ends, if necessary, by the introduction beneath them of a small piece of lint or strapping. Instead of silk being twisted round the pins, a section of an india-rubber tube in the form of a ring has been employed by Mr. Rigal, and the late W. L. Atlee of Philadelphia. The ring is slipped over the ends of the pin, and serves by its elasticity to keep the parts together.

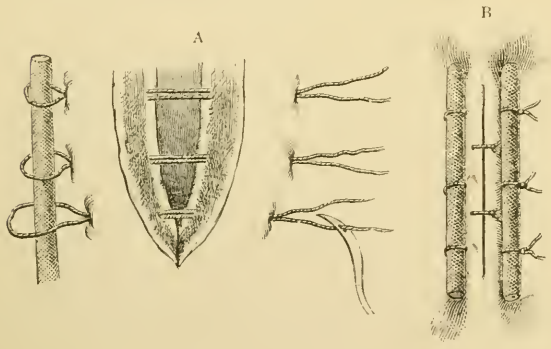
Fig. 6.



The Twisted Suture.

Quilled Suture.—This form of suture (Fig. 7) is applicable where deep wounds have to be well held together along their whole line, and more particularly for a brief period, say two or three days. In ruptured perineum it used to be in general use combined with superficial sutures, but the interrupted sutures of silkworm gut, introduced well away from the margins of the wound and inserted deeply, are probably to be preferred.

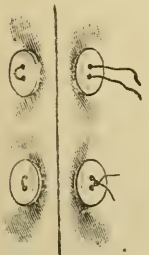
Fig. 7.



The Quilled Suture.

For the application of this suture, a strong curved needle with an eye at the end and threaded is to be inserted at least three-quarters of an inch from one margin of the wound and made to pass well down to its depths, then brought out through the other margin in a corresponding line. The loop of the suture should now be caught and held and the needle withdrawn; a piece of bougie, cut the required length, being introduced into the loop, is fixed by drawing the free ends of the ligature home (Fig. 7 A). A second or third suture can be applied in the same way. A second piece of bougie ought then to be tied on the opposite margin of the wound, the parts having been well cleansed previously and carefully adjusted. The surfaces of the wound are only to be held closely in apposition, and must not be pressed too firmly; otherwise, the bougies will set up ulceration. Superficial sutures may subsequently be introduced into the edges of the wound (Fig. 7 B).

Fig. 8.



Button Suture.

For the quill suture good fishing-gut is better than silk or wire, as it is strong and unirritating. Before use it should be soaked in water, to make it limp; it can be readily tied or fastened with a shot. The loops of the quill suture should generally be divided on the fifth or sixth day, but this depends on the amount of irritation caused by the bougie.

The **Button Suture,** as a variety of the quill, is useful in some amputations, as the thigh, where the surgeon is desirous of keeping the bases of the flaps together, and in breast cases and in hare-lip or other lip operations (Fig. 8).

Material for Sutures.—With respect to the material used for sutures, silk, wire, silkworm gut, prepared catgut, or horsehair are each good in certain cases when rightly selected. When there is little tension on the sutures,

silk or wire may be indifferently employed, the amount of irritation exerted by one or the other material depending more upon tension than on any other condition. I have long proved this to my own satisfaction by testing both forms of suture in the same subject through a long series of cases.

In *plastic* operations silkworm gut well softened in water before use is to be recommended; it holds well, and seems to irritate far less than any other material. In cases of ruptured perineum and in operations for vaginal fistula and fissured palate it should always be used. In the latter class of cases, where the soft palate alone is involved, horsehair is good, but it is not strong enough to resist much tension.

In plastic operations, in which some skill may be called for in adjusting the parts, wire sutures may be selected, since they can be twisted and untwisted with facility, and the surgeon can consequently readjust the margins of the wound as required to his satisfaction.

Prepared catgut is not a reliable material for sutures, since it is uncertain as to its retaining power and is apt when sodden to yield; it is, however, useful as a suture in holding parts together for a brief period where there is no tension, and where there may be a difficulty in removing the stitches subsequently. In operations on the penis it is of special value.

Value of Pressure.—The effectual carrying out of the third indication in the treatment of incised wounds—viz., the coaptation of the two divided surfaces of the wound, deep parts as well as edges—is not, however, always to be accomplished by means of sutures and strapping, however well selected and applied these may be. Other means are constantly demanded, and of these well-directed *pressure* is the most important, as ably advocated by Gamgee. Indeed, the value of pressure in the treatment of all wounds is worthy of more consideration than it has received. By it the surfaces of divided parts are kept together, and particularly the deeper surfaces; mobility of the injured tissues is checked, if not prevented; the vessels of the wounded parts are supported; and the evil influence of blood-stasis, with its effect, effusion, is neutralized. Under these circumstances repair is helped, and nature's processes are permitted to go on under more favorable conditions. With this view of the value of pressure, well applied pads of lint, absorbent cotton-wool, gauze, or sponge, saturated or not with some antiseptic drug, should be carefully adjusted over the flaps of all wounds when such exist, and over the surfaces of others. These pads are kept in position by means of strapping or bandages, aided by splints when the extremities are involved. After the removal of a breast or tumor, the value of a well-adjusted pad, and more particularly of sponge wrung out of iodine or carbolic water, cannot be too highly praised. After an amputation, the use of a splint adjusted to the stump, and pressure well applied to the bases of the flaps, not to the edges, should never be omitted.

Fourth Indication.

The Maintenance of Wounded Parts in such a Position of Immobility as may be Favorable to the Natural Process of Repair and Comfortable to the Patient is the fourth indication in the treatment of incised wounds; and, to say the least, this is as important as the preceding indication, since, if neglected, the benefit that might be expected from efficiently coaptating the wound could not be realized, and the process of repair in the wounded part would of necessity be checked, if not altogether prevented.

To carry out this indication, *immobility* of the wounded part is of the first importance, and its *position* next. The position is always selected with the object of giving ease to the patient and of preventing pain; of relaxing the wounded tissues, and so guarding against any tendency to bring about a separation of the edges of the wound, as in cut-throat cases; and last, but not least, of encouraging the return of the venous blood from the wounded parts toward the heart. Thus, in wounds of the trunk the horizontal position is the right one to be maintained, and in those of the extremities flexion and elevation of the limb; in wounds of the lower extremity the foot should be kept higher than the knee, and the knee than the hip; and in those of the upper extremity the same principles of practice should be followed, the elbow being generally flexed. Under all circumstances wounded limbs should be fixed upon splints, with the view of immobilizing them, and, as a rule, they should be swung. This practice adds greatly to the comfort of the patients by allowing them to move their trunks without their wounded extremities, and without, therefore, interfering with repair. It should be added, however, that the question of position ought always to be considered in reference to the *fifth* indication—

namely, the necessity of providing efficient means for the removal of the superfluous fluids of the part, and for the escape of disintegrated dead tissue which may have to be discharged, or, in other words, for *drainage*.

Fifth Indication: Drainage.

Drainage, or the making of due provision for the escape from the wound of disintegrated dead tissue, with such fluids as are not required for repair, and which, if left, might prove injurious, is of primary importance in the treatment of all, and more particularly of deep, wounds. It should never escape the attention of the surgeon. In scalp wounds and those about the eyelids, though they may appear trivial, it is of as much importance as it is in the wounds that involve deeper parts and seem more severe; for in the one case, as in the other, pent-up fluids not only separate tissues which are intended to unite, give rise to pain by producing tension, and consequently cause constitutional irritation, but they are prone to excite inflammation in the part, and ultimately to undergo septic changes, which in their turn may give rise to blood-poisoning in the form of septicæmia or pyæmia.

No other than trivial wounds, consequently, should be completely covered in, and deep ones very rarely. Some corner, and preferably that which is the most dependent—some interval between the sutures or strips of the plaster—should always be left open for the escape of disintegrated tissues and of superfluous fluids, such as blood or serum, and where deeper structures are involved some conducting material, or "drainage-tube," should be introduced. The best is a tube of india-rubber perforated at intervals (as originally suggested by Chassaignac, 1855), of a size varying with the cavity or wound to be drained; but in some cases a strand of carbolized catgut or horsehair, a roll of gutta-percha skin, or a piece of lint saturated with carbolic or terebene oil will do as well. In abdominal cases, as after ovariotomy, a perforated glass tube is of great value, while under other circumstances an elastic catheter will answer the purpose. The particular mode of accomplishing the object is of little importance, so long as the object itself is secured.

Caution in Use of Drainage-Tube.—In using a drainage-tube, however, the surgeon must remember that it is not to be made a seton, and that the sole justification for its use is to drain the fluids from the deep tissues. For this purpose the tube is to be made to dip deeply enough into the wound, but no more; it is not to be made a cause of irritation. The size of the tube is to be regulated by the requirements of the case; several short tubes are often better than a long one. Care is also to be taken that the outer ends of the tubes are left free: when covered, they should be covered but lightly, and then with some absorbent cotton, oakum, sponge, or gauze. As a rule, however, they should be left open.

Position of Tube.—In using the tube, when the end is cut off level with the wound, the outer extremity should be held by means of loops of carbolized silk, perforating its walls and secured externally by strapping or other means. The tubes should always be introduced at what will be the most dependent part of the wound when the patient is in the recumbent position, and they should be taken away as soon as they have answered their purpose. When quick or primary union has taken place, they may safely be removed at the end of twenty-four or forty-eight hours; but when suppuration is present, they must be left longer—sometimes even till the cavity has nearly closed. A drainage-tube should, however, be shortened as rapidly as the progress of the case will allow, the shortening of the tube and the closing of the cavity of the wound from below going on together.

It is to be noted that at the present day the use of drainage, whether by tubes or other material, is suggested with the view of *preventing* suppuration in the treatment of deep wounds; whereas in former times, when Chassaignac introduced his tubes, it was for the treatment of wounds and cavities in which suppuration already existed.

The value of the principle is, however, equally great in both classes of cases. When carbolic acid is used as a wound-dressing, whether as a spray or as a lotion, or when chloride-of-zinc lotion is employed, the use of the drainage-tube is more necessary than it is when other forms of dressing are employed, since under the stimulating influences of these drugs there is, as Lister tells us, more effusion of plasma than is to be looked for in other circumstances.

Caution in the Closure of Wounds.—Whenever a wound is closed, with the view either of obtaining rapid or primary union or of converting an open as far as possi-

ble into a subcutaneous wound, the most careful inspection is called for, to guard against, and even to anticipate, trouble. In these cases the wound should be opened on the slightest approach of local tension or overaction with elevation of temperature and traumatic fever, since such local and constitutional disturbance will probably be found to be due to the retention of some of the fluids of the part that are in excess of what is wanted for repair, and can be relieved only by the evacuation of such retained substances.

Sixth Indication: The Protection of the Wounds, etc.

The protection of the external wound from all such outside influences as may be prejudicial to the progress of natural repair is the sixth and last indication for the surgeon to follow; and it is in itself as important as the five which have preceded it, since it includes the use of all means by which the wound can be protected from outside injury, as well as the dressing proper or covering of the wound.

For purposes of protection, most wounds require a covering; and when they are on the extremities or other exposed parts, they also need some cradle or other mechanical appliance to keep off the weight of the bedclothes. In wounds of the face, however, coverings are rarely required; for all surgeons are familiar with the fact that there are no wounds, operative or accidental, that do so well as these without any external application, provided that they have been carefully brought together and adjusted. Indeed, it is probably from a knowledge of these facts that the *open method* of treating wounds has been advocated. This method cannot, however, be recommended, except for wounds of the face. For some years past I have been in the habit of dressing all wounds with dry absorbent lint or with lint soaked in a mixture of terebene one part and olive oil three parts, and have every reason to be satisfied with the practice. I simply cover the oiled lint with a second piece of dry lint and fix the whole with a retentive bandage, room being left for drainage in all cases in which quick union is not to be expected, either by loosely covering one corner of the wound which is left open or by perforating the lint covering the wound, to allow of the protrusion of the end of the drainage-tube. Cotton-wool of the absorbent kind is then arranged about the tube, to absorb all fluids that escape, but not in any way to arrest their flow, since to insert a drainage-tube and then smother up its orifice seems inconsistent practice.

When the spray-and-gauze system (*Listerism*) is adopted, all the precautions required for security must be observed, the principle upon which this system is based being one of exclusion, not only of air, but of all germs that may be floating in it, and which are supposed to be the cause of suppuration and of the decomposition of organic fluids.

Wet applications, and more particularly watery ones, are now seldom used, and cannot be recommended, since it is well known that by moisture decomposition is encouraged. When they are employed, they should be medicated—that is, they should contain some drug which has an influence in preventing or arresting decomposition, or in neutralizing the evil effects of the chemical changes which are sure to take place either in the contused or devitalized tissues or in the poured-out fluids, whether blood, serum, or pus. The best of these drugs are chloride of zinc, carbolic acid, boracic acid, alcohol, terebene, thymol, iodine, the permanganate of potash, and iodoform.

On the Second Dressing of a Closed Wound.

No fixed period can be named when the first dressing should be removed from and a second applied to a wound which is being treated with the view of obtaining healing by "quick" or primary adhesion. But this is certain—that no interference should be allowed under a week unless there is some indication, either in the form of local discomfort or pain, or some constitutional symptom, such as an elevation of temperature with febrile disturbance, to justify the act. In truth, to use a legal phrase, the surgeon should in all cases show cause why he should interfere before he does so; for it is not to be denied that in changing dressing, even with the gentlest and most skilled manipulation, there must of necessity be some interference with the reparative process, some slight tearing away of the new reparative material, some taking away of support where support is essential or removal of local pressure where such is needed; in fact, there must always be some injurious influence upon the healing part which should not be permitted without a compensatory good effect.

A wound treated for repair by primary adhesion, if left alone, will probably, under favorable circumstances, heal within the week; and a large wound, such as that made in

ovariotomy, in excision of the breast, or in amputation, will heal within two weeks under the best conditions. If it does not, it is because there is something wrong with the patient's general condition, or something wrong in the wound, or more particularly in its treatment; for the primary dressing of the wound should have been such as to render early interference with it unnecessary.

To recapitulate: (1) the edges and surfaces of the wound should be carefully adjusted and fixed together; (2) complete immobility of the injured part should be guaranteed by the judicious application of splints, pads, and bandages; (3) the limb or wounded part should be placed in the most comfortable position for the patient, as well as in that which is most favorable for repair; (4) due provision should be made for the effectual drainage of the wound, and care should be taken that the effect of drainage is not neutralized by any external application or dressing; and, lastly (5), such dressings or external coverings should be employed as will protect the wound from external injury and guard against or neutralize the decomposition of such fluids as may be poured out.

A wound, however large, dressed *effectually* on these principles, will probably not require dressing for a week, or will not need more than the removal of the absorbent material which has been placed to catch the secretion which has drained away from the wound, and will be found, when dressed, to be well or nearly well. A wound, however small, dressed ineffectually, will probably be unhealed and suppurating.

The nearer the surgeon can approach perfection in his first dressing, the more successful will he be in his practice, and the larger will be his proportion of cures by primary adhesion.

When a *second* dressing is called for, the surgeon should have at hand everything which may be required for the purpose—lint, prepared in size and shape, and steeped in whatever dressing he may have arranged to use; scissors, forceps, bandages, strapping, absorbent cotton, trays, and irrigators, whether in the shape of a can or in that of a dressing-bottle (Fig. 3, p. 33).

Removal of Dressings.—When the wound is large and water is to be used in quantities, he should have a piece of waterproofing to place beneath the part or patient, and such assistants as may be required. He is then to remove the external dressings; and in doing this, as in every subsequent procedure, he is to employ the utmost gentleness. He should, however, beforehand place his patient in the most comfortable position he can, and then place himself comfortably; for no surgeon can do his work well if he is in a constrained posture.

In removing external dressings some time is often required, but it must be granted; for when dressings are glued to a wound by blood or secretion, they must be softened with water—or, rather, medicated water—before they can be taken away without doing harm. Having taken off the external dressings, rolled them up, sent them away, or thrown them into a basin of antiseptic fluid, and having exposed the wound with its sutures, and the strapping which possibly was applied for adjusting purposes, the surgeon is then to cleanse the part; and for this object he cannot do better than use the absorbent cotton, either dry or wetted with the medicated lotion. The sutures should then be cut and withdrawn, care being observed not to drag a long loop of suture covered with dry secretion through the tissues, but to cut it off close to the skin through which it will have to pass. When the union of the wound appears weak, or when, on an early day after the first dressing, the second is being made, support should be given to the tissues by the application of a piece of well-adjusted strapping as each suture is taken away, a second and third, or more, pieces being successively applied as the dressing proceeds.

Removal of Sutures.—If the sutures are not irritating and the wound has not healed well, they should be left alone. In deep wounds the surgeon should never be in a hurry to remove sutures, whether they are irritating or not, for if he remove them before good repair has taken place the wound will gape, and under such circumstances the prospect of securing repair by primary adhesion will have disappeared; and even when the sutures are cutting through from overstretching of the part, it is, as a rule, well to let them alone as long as they have any influence in holding large flaps together or in preventing wide separation. At the same time, all sutures should be removed as soon as they have answered the purpose for which they were introduced, or when all hope of their fulfilling it has passed away. The removal of a stitch from a wound which is suffering from the irritation caused by tension, and possibly from some collection of fluid, is always wise.

When splints have been used to support and to ensure the immobility of wounded parts, they should not be removed unless for some urgent cause. It is to be assumed

that they were so applied at first to allow the surgeon to remove, when necessary, the external dressing without interfering with them. With the same view, of preventing the necessity of its early removal, a splint should be covered with some protective, such as gutta-percha or oiled silk.

To complete the second dressing, a fresh piece of lint soaked in the terebene and oil, or other selected application, is to be laid on the wound, and the external parts covered as after the first dressing, the surgeon taking care to see that efficient means are employed for the external protection, the immobility, and good drainage, of the wound.

Subsequent Dressings.

The third and later dressings of a wound must be governed by the same principles which have been laid down for the second, and they are to be conducted in the same quiet, gentle, and yet decided, manner. They are not likely to be very numerous should primary adhesion be obtained; and when that hope has fled, they must be carried out daily, or possibly more often. They will, however, then have to be conducted on very similar principles, although with different objects.

Contused and Lacerated Wounds.

These wounds, from a clinical point of view, should be classed together, since, in both, the edges of the wound are, as a rule, so injured as to be irregular and the seat of ecchymosis, and since, in both, before repair can practically begin, death of some of the injured surface, or of some of the surrounding subcutaneous or other tissue, or margins or flaps of the wound, is to be expected.

In the *contused* wound the breach of surface is brought about by a blunt instrument, moving with a greater or less velocity; and the extent of bruising or contusion of the soft parts in the neighborhood of the wound will be found to vary with the size of the instrument which inflicted the injury, and with the force of its impact. When the missile is large, the extent of injury will be proportionate; and when the velocity is great, the area of contusion around the edges of the wound will be lessened as the extent of wound will be increased.

The most typical examples of contused wounds of all kinds are met with in military practice, and are caused by the impact of spent balls or fragments of shell.

Lacerated wounds are generally brought about by a tearing or biting process, and are characterized by great irregularity of the lacerated tissues from the skin downward; this irregularity depends much upon the different degrees of elasticity of the parts torn, skin, arteries, muscles, and tendons all behaving differently when submitted to a lacerating force.

In *contused* wounds the area of injury generally extends far beyond the area of the breach of surface; and when death of tissue follows, it may spread widely. In *lacerated* wounds the area of injury is generally more localized, though this remark is not applicable to wounds in which muscles and tendons are involved. When, for instance, a finger or thumb is torn off, the tendons connected with the injured part may separate at their muscular origins in the fore-arm.

Hæmorrhage.—In both contused and lacerated wounds there is less primary hæmorrhage than there is in those of the incised variety; the *contusing* force so affects the vessels at the seat of injury as to favor the coagulation of the blood about their open mouths, or so ruptures the inner and middle coats of the bruised vessels as to mechanically interfere with the flow of blood, and thus encourage the formation of a clot by which the lumen of the injured artery may become occluded; the *lacerating* force likewise irregularly divides the different coats of the vessel and its sheath—even in the case of a large artery—and thus favors the coagulation of the blood at the seat of laceration. This temporary plug of the vessels is generally sufficient to close the orifice until nature's permanent hæmostatic processes have had time to act and to seal the vessel (*vide* Chapter X.).

Secondary Hæmorrhage.—In contused wounds there is a far greater proneness to secondary hæmorrhage than is met with in any other form of wound, the contusing force often primarily injuring, but not opening, an artery, yet so destroying the vitality of its coats as to excite an inflammatory, sloughing, or ulcerating process, which in its turn may open the vessel and give rise to secondary hæmorrhage. Contused wounds are for this reason of a more dangerous character than lacerated wounds.

Subcutaneous Contused Wounds—that is, severe contusions of soft parts without breach of surface or exposure of the injured tissue from either the impact of blunt instruments, the passage of a wheel over the part, or other force—are at times more grave than those in which a breach of surface exists. The gravity of these cases is best seen by studying the effects of such kinds of injury upon the abdominal and pelvic viscera, an unbroken and apparently uninjured outside surface often covering a fatal subcutaneous rupture of a solid viscus or a laceration of a hollow one. The same fact may be also well seen in severe injuries to extremities, where from a contusing force an artery may be stretched, bruised, or lacerated, large veins may be torn across, nerves injured, and muscular and other tissues irreparably damaged. The amount of harm which deep tissues may have sustained in any given injury can, therefore, only be estimated by a correct appreciation of the force which has been applied, and of the position and condition of the injured part at the time of the reception of the injury. It can never be made out by simple inspection of outside appearances. Such injuries always demand great care in their treatment.

Treatment of Contused, Lacerated, and other Wounds which Heal by Granulation.

The principles upon which the treatment of contused, lacerated, or open wounds is based are the same as have been laid down and explained in considering the treatment of incised wounds, though they may require some modifications in their application, on account of the altered circumstances in which they have to be carried out. For example, in a deep *lacerated* wound the surgeon will have to cleanse it and arrest bleeding, as in an *incised* wound; but he will not have to adjust the divided surfaces and apply sutures in the same careful way that he would be called upon to do if a "quick union" was to be looked and worked for. He will remember that this change of practice is demanded in contused and lacerated wounds because there must of necessity be more or less sloughing or molecular disintegration of the lacerated tissue and contused parts around, and that, as a consequence, it becomes a matter of primary importance to leave the wound open for the free discharge of all such tissues as may have been destroyed or may die, as well as for the evacuation of the fluids which must be poured out in the reparative process.

He will, however, in this class of cases, as in the former, secure immobility of the wounded part and fix it in the position which will be easiest to the patient and most conducive to the healing, and he will not forget to make the fullest provision for the drainage of the wound from its lowest depths. He will, moreover, have to be additionally careful in the dressing of the wound, since it is an open one, because, from such, septic matter is more rapidly absorbed before the process of granulation has commenced; and when it has commenced, such a wound is readily influenced by external applications.

In *one* instance the wound may have to be regarded and treated as an open one from the first, the excavated surface being filled in with a light dressing, as if it were a surface wound. In *another*, where there is a tendency for the surface edges to fall together and unite, and where this union would be injurious by interfering with the free evacuation of such discharges as are to be looked for from the wound, or with the escape of sloughs of destroyed tissue, the dressing may have to be inserted between the lips of the wound, or even down to its bottom, for it is essential in these cases that the wound should not be closed and that a free vent for all fluids should be maintained; whilst in a *third* case the provision for free drainage may, from the position of the wound, be so imperfect that a special opening (counter-opening) may be called for at the most dependent situation of the injured parts, or at some other position which the ingenuity of the surgeon may suggest. Under all circumstances, wounds such as these, which are not expected to heal by quick union, should be so dressed as to allow of the free egress of all secretions without disturbing the parts.

The primary dressing which I am in the habit of employing for fresh wounds is, as already mentioned, lint or absorbent cotton saturated with a mixture of terebene one part and olive oil three parts, the saturated dressing being covered with another layer of dry lint or cotton. Where a wound has to be lightly filled with some dressing, I use the absorbent cotton semi-saturated with the same terebene-and-oil mixture, and a light pad of the absorbent cotton applied over the whole and held in position by a retentive bandage; and even when a drainage-tube or drain-orifice exists, the same light dressing is useful to absorb such fluids as may escape externally In some cases a soft sponge which

has been wrung out of iodine or carbolic lotion is a good substitute for the wad of absorbent cotton.

In cases of more severe wounds, where a free flow of fluid is to be expected, and where the danger of its retention would be great, the opening of the drainage-tube or discharging-orifice should be left free. In the dressing of all stumps and most deep incised or lacerated wounds this practice should be followed, since it enables the surgeon to bring the parts more accurately together than would otherwise be advisable, and to keep them quiet, and in apposition by means of pressure applied over the whole of the wound, except the drain-orifice. This method has likewise the additional great advantage of allowing the surgeon to leave the wound undisturbed for some days, probably for a week, and to postpone his first dressing till a period when nature's reparative process will have had time to shut off the wounded part from the deeper tissues, and to do much in the direction of its repair. There should always be a reason for dressing a wound. Dressing as a routine practice is not to be commended; it should always be deferred till it is required.

Wounds must be kept *clean* under all circumstances, and free from every septic risk; but a wound must be kept *quiet* if repair is to go on steadily, and this quiet is as necessary for the lacerated as it is for the cleaner kinds of wound. A form of dressing such as has been described has advantages over many others, for it renders early and frequent dressings of the wound unnecessary.

Punctured Wounds.

Punctured wounds, when made with sharp-cutting instruments, are deep *incised* wounds, and when with blunt or wedge-shaped tools deep *contused* wounds. They differ from other incised and contused wounds in their depth and in the uncertainty which, as a consequence, follows with respect to the tissues that are wounded, but, above all, in the difficulties which are always experienced in providing for the efficient evacuation of blood, serum, or broken-down tissue, where drainage is needed. These difficulties are clearly due to the external orifice of the wound being but small in proportion to the depth of the penetration.

When a punctured wound is made with a *clean, sharp instrument* into the healthy tissues of a healthy subject, harm may not be anticipated; indeed, quick repair may be looked for with almost as much confidence as if the wound had been of the more simple incised kind. This observation is confirmed by the general experience of all who practise subcutaneous surgery, although when large vessels or nerves are wounded troubles may arise which are not lessened by being hidden.

When, however, a punctured wound is made by a *blunt and wedge-shaped*, or possibly a *dirty*, instrument, the wound will be of the contused kind, and, being so, it will partake of the disadvantages of such wounds in addition to those which appertain to it as a punctured wound. It will consequently, being contused, be associated with death of some of the injured tissues, for the escape of which due provision will be required, and it can only be expected to heal by the second or third intention. Being a punctured wound, it will, moreover, exhibit the difficulties of providing for proper drainage under circumstances in which efficient drainage is particularly called for. As a consequence of these conditions, special dangers are developed which can only be rightly met by a full recognition of their nature and of the requirements essential to their prevention.

When tense fasciæ are punctured—such as are found in the palm of the hand, sole of the foot, and scalp—or when deep muscles bound down by fasciæ, as in the thigh, are involved and secondary inflammation ensues, the case is often very serious. Punctured wounds of cavities are worse than those of the soft parts covering bones, in the same way that all other wounds of cavities are graver, as well as from the fact that in punctured wounds there is more uncertainty as to the nature of the parts wounded, and that with this uncertainty there are, of course, less clear indications for treatment.

Treatment of Punctured Wounds.—There is no form of wound which the surgeon has to treat in which a greater uncertainty exists as to the results of treatment than in the punctured, and all punctured wounds should be dealt with, therefore, with the greatest caution. When the wound has been accidentally inflicted with a clean, sharp instrument, and when it is treated, as it should be, like any other clean wound, with moderate compression and the application of a dry or antiseptic dressing, such as terebene and oil, and is then left protected and at rest to heal, there will be every prospect of repair going on as satisfactorily as in wounds which surgeons daily inflict in their

operations of tenotomy and osteotomy. Even when the wound is of the contused kind and repair by "quick union" is not to be looked for, the surgeon is probably justified in employing the same means, although in doing so he must be keenly alive to the risks of the case and the dangers of the practice adopted. He must be ready, on the appearance of any swelling, pain, heat, or redness, and more particularly of any elevation of temperature, to remove all dressings, expose the wound, and adopt means to give vent to the pent-up fluids of the part and relieve the local irritation caused by their retention; by so doing he will put an end to tension of the tissues, and probably check the further absorption of substances which, if not already decomposing and undergoing chemical changes, may soon do so and give rise to septicæmia and blood-poisoning.

In one case this may be done by reopening the external orifice of the wound; in another, by enlarging it; whilst in a third, a fresh opening may be called for in the most dependent point of the injured region. Under all circumstances, however, the object is the same—to give vent to pent-up fluids, whether inflammatory or otherwise. At the same time, the injured part should be raised, to encourage the venous circulation through the limb, and pain should be relieved by the local application of warmth and moisture, whether in the form of a compress or in that of a fomentation mixed with sedatives, such as opium or poppy decoctions.

Cold rarely gives comfort in these cases, and it certainly does no good toward checking inflammatory action, which, if occasioned by retained secretion, is only to be relieved by its removal. For the same reason leeches are rarely applicable, although in a plethoric and vigorous patient they may be permissible: but even in such the judicious use of small and repeated doses of sulphate of magnesia has a more powerful effect for good, with less risk of doing harm.

In the treatment of all punctured wounds it must be remembered that, as the chief danger lies in the difficulty of providing efficient drainage, the result turns upon the completeness with which this necessity is met. The surgeon who, on the first appearance of local or general symptoms indicative of the presence of retained serum or other fluids, makes an outlet by one of the means which have been suggested, will be more successful than one who, from timidity or other cause, leaves the case to run its course till a large inflammatory abscess has formed. In all punctured wounds which do not heal quickly by primary union, and in which secondary inflammation occurs, with its necessary effusion, an outlet should be made for the fluids of the part as soon as the fact of their retention is clear. When theeæ of tendons, fasciæ, and fibrous coverings, as of bones, are involved, the necessity of providing for this outlet is more important, if possible, than when the softer tissues are implicated, and an incision into the deep parts for the evacuation of simple serum, by relieving tension, will often prevent both the extension of the inflammation and the destruction of tissue.

Tooth Wounds.

Tooth wounds are usually punctured, and rarely other than contused. They may, as may all other kinds, prove to be poisoned wounds, but to them I do not refer. They differ widely in their character, and, whilst one case may appear as a simple clean punctured wound, another may exhibit all the worst features of the contused or lacerated variety.

They are to be dealt with as punctured or contused wounds, each case being treated on its own merits.

Treatment of an Open or Granulating Wound.

When a wound is granulating, and consequently suppurating, it should be kept clean, as should all wounds, and it should be dressed with such a material as may best protect the granulations from outside injurious influences and allow the cicatrizing process to go on without hindrance. The granulations themselves should never for purposes of cleanliness be touched by any coarse material harder than a camel-hair pencil, but should be washed by means of a stream of some antiseptic fluid allowed to flow from either the irrigating-bottle or dressing-can (Fig. 3). In my own practice iodine water is generally used. When the granulating process is not of a healthy type, but shows either deficiency or excess of power or some morbid action, medicated lotions and constitutional treatment may be required, to which attention will be directed farther on.

Treatment of Wounds to Promote Healing by Secondary Adhesion.

As in the treatment of a fresh wound to obtain a "quick or primary adhesion" the surgeon has simply to cleanse the wound after arresting bleeding, and to bring the two surfaces into close apposition by the simplest means, and keep them so, thus in the treatment of a case in which healing by secondary adhesion is sought for he has simply to bring together the two granulating surfaces, cleansed from all impurities by such means as are suggested by the special requirements of the case, and to leave them to unite. In hare-lip or other lip operations, where quick union has been missed and secondary adhesion is sought for, it may be obtained by the introduction of deep sutures, or even pins; in deep flesh wounds or after operations, as on the breast, by means of strapping well applied; and in stumps, after amputation, by means of splints, pads, and bandages. In all cases, the immobility of the part treated is subsequently to be rigidly attended to, and time must be given for union to complete itself before the dressing is disturbed.

The Special Treatment of Wounds.

To estimate correctly—with the light of our present knowledge—the value of any special method of treating wounds, it is necessary to keep constantly in mind the *six points* to which attention has been directed, since these points are essential principles of practice which should be followed under all circumstances. Indeed, so essential are they that the value of any special method of treating wounds may be tested by them, and the method regarded as good, bad, or indifferent according to the measure or degree in which it fulfils the requirements enumerated (*vide* page 34). A mode of dressing which satisfies all these requirements or indications in a simple and efficient way must be regarded as perfect, and a mode which embodies in itself the greater number of these requirements should be regarded with greater favor than another in which these requirements are less efficiently fulfilled.

With this standard of comparison ever prominent, I will now proceed to consider the more important special modes of treating wounds.

The Treatment of Wounds by Occlusion (the Smothering System).

This was, without doubt, the favorite method of dressing fresh wounds among the older surgeons, and in proof of this it is only necessary to refer to the classical works of John Bell to read how the processes of *mundifying*, *digesting*, *incarning*, and *cicatrizing* were carried out.

This method was doubtless the outcome of much observation, and was based on what was seen daily in the healing of the wounds of animals by one of the natural methods of repair—that of scabbing. "This mode of healing under a scab" "is the most natural and in some cases the best of all the healing processes. Very commonly, in animals, if a wound be left wide open, the blood and other exudations from it dry on its surface, and, entangling dust and other foreign bodies, form an air-tight and adherent covering, under which scabbing takes place, and which is cast off when the healing is complete. The exact nature of the process has not been watched, but it seems to consist in little more than the formation of cuticle on the wounded surface, and it has the advantage that, as no granulations are produced, there is little or no contraction of the scar. In man the same process is less frequent; it is more apt to be spoiled by inflammation, producing exudations under the scab, which either detach it or prevent the healing of the surface beneath it. Sometimes, however, the blood shed from a wound coagulates and dries on it, and, remaining as a scab, permits healing under it; or if this does not happen, a similarly effective scab may be formed by the serous fluid or lymph by which the surface of an exposed wound usually becomes glazed; or, more rarely, the pus of a granulating wound may scab, and sound healing take place beneath it. . . . ."

"To obtain healing under a scab, if the wound be recent the blood and exuded fluids, or if it be granulating the pus, should be left exposed to the air till it dries on the wound, adhering to the edges and surface and *completely excluding them from the air*."

"There seems, however, to be a proneness to inflammation which makes the healing under a scab precarious, and less generally obtainable than one could wish it. No morbid

exudation should take place under a scab once formed; everything of the kind painfully compresses the wound and retards its healing. . . . ."

Such is the mechanism of healing under a scab, and such are some of the methods by which it can be brought about. In Sir A. Cooper's time (1820–40), with the same object, wounds were often sealed with lint or other material saturated with blood, and in more recent days they have been covered with collodion alone or applied on linen, with colloid styptic, with tannin in powder, with dry earth or peat, with Peruvian or Friar's balsam, with cotton-wool medicated or otherwise. In some country districts coal-tar is used for the same purpose, and with the same view. Chassaignac's arrangement, by which a wound was hermetically sealed from the air by consecutive layers of plaster covered in with charpie or cotton-wool, has also been employed. The object of each variety of this form of dressing is the same—viz., *the complete occlusion of atmospheric air*—and in each an attempt is made to place an open wound as much as possible in the position of one which is closed or subcutaneous.

Cotton Dressing.—In recent times this method has attracted much attention under the form of the "cotton dressing," which was introduced in 1853 by Burggraeve of Ghent and advocated by Ravoth. In their hands it was carried out by the immediate application of splints thickly padded with cotton-wool to the wound and injured limb, and by not interfering with the injured part for four or six days. If there was at the end of that time neither inflammation nor suppuration, but a firm scab, the wound was let alone, and only the surrounding wool was removed. If suppuration was present, the wound was dressed with cerate. This method has been described by Schultes as the methodical application of so-called healing by scabbing extended to large wounds.

Dr. Gräf uses cotton-wool and tannin, the latter being spread over the wound in a layer as thick as the back of a knife; he leaves the dressing untouched from four to fourteen days. He and Fleck of Dresden regard tannin as a simple and cheap antiseptic and disinfectant, and as an unirritating hæmostatic. Both surgeons advocate this method of treating wounds in military surgery. Alphonse Guérin uses cotton-wool with the view of filtering the air from germs before it reaches the wounded surface, and he applies the wool by smothering the wounded part or limb with many layers, and leaving it undisturbed for twenty-four or thirty days unless some extraordinary complication should arise—for the detection of which a close watch is always kept—to induce him to remove it. Before he applies the dressing he washes the wound with camphorated alcohol or carbolic acid, and in an amputation introduces the wool between the flaps. When the dressing is removed, there is generally a healthy granulating surface with a little sweet pus covering it, and the granulations, in the case of a stump, have probably driven out the cotton-wool. This method has the advantage of giving rest to the wounded parts; the gentle and elastic pressure exerted by the wool is also beneficial, as are likewise the constant temperature maintained and the freedom from pain which is the result of these conditions.

Ollier employs the same dressing as Guérin, but he, in addition, sprinkles the wadding with carbolic acid. According to either plan, the dressing is a close one, and is based on occlusion of the part from air, with antiseptic precautions.

Summary.—If we bring this method of treating wounds by "occlusion" to the test laid down at the commencement of this section, it will be found that it fairly well fulfils three out of the last four essential principles of practice, but fails entirely in the most important, the fifth—that of drainage. That is to say, excepting in A. Guérin's practice, it includes the careful adaptation of the surfaces of the wound, ensures rest and immobility of the part for some days, and provides for the protection of the wound from outside influences and for antisepsis, but it fails entirely in making the smallest provision for "drainage;" so that, as Syme cleverly expressed it, "there can be little difficulty in perceiving why the sealing up of wounds should be the most certain means of keeping them open."

Under these circumstances the conclusion is clear that, whilst this may be a safe and wise practice to adopt in small or superficial wounds, it is a risky and somewhat dangerous method to follow in the treatment of those which are deep and complicated unless very closely watched. It should never be employed in any case in which the wound is more than superficial unless the probability of the part healing by immediate union can with good confidence be maintained, and it should never be employed at all unless the surgeon, carefully watching the temperature of the patient and the local and general symptoms of the case, is prepared to at once expose the wound, if necessary, and to evacuate any pent-up fluid that may be present. For my own part, whenever I seal a wound with the hope of securing a good result by allowing the parts to heal quickly, as in a

subcutaneous or closed wound, I never do more than seal it with lint soaked with blood or Friar's balsam, and I take good care to have the parts otherwise well exposed to observation, in order that I may, if warned by the appearance of any local symptom, such as swelling, heat, or pain, or of any general symptom, such as increase of temperature or fever, remove the scab, real or artificial, and give free vent to the pent-up fluids. I, moreover, never adopt the method for any other than a very clean and recent wound.

As a general mode of practice this treatment by occlusion is not to be advocated; in exceptional cases it may be employed, but then only with extreme caution. In most deep and complicated wounds it should be rejected. It is only applicable in the very earliest treatment of wounds.

The Open Treatment of Wounds, or Treatment by Exposure.

This method was first systematically carried out by a Vienna surgeon named Vencenz von Kern in the beginning of this century, and more recently by Bartscher and Vezin in 1856, and by Burow in 1866. These German surgeons were led to adopt this mode of treatment by careful observation of the healing process in wounds, and more particularly by the bad results which followed the ordinary methods of dressing by occlusion, as then employed in continental towns, by the use of bandages, charpie, lint, etc. The system of dressing wounds by what has been described as the "smothering method," in which no air could get in or fluid get out, gave way to the "open method," in which the free access of air was the main end sought for, and drainage the second. The success which attended this practice was, moreover, considerable, since Bartscher and Vezin had only three deaths out of thirty amputations, and Burow three out of ninety-four. The method, nevertheless, did not make headway, and it does not seem to have been followed as a rule of practice by any surgeon except Messrs. Teale of Leeds, Professor Humphry of Cambridge, Dr. R. W. Krönlein of Zurich, and some members of the Surgical Society of Moscow.

Teale and Humphry in 1850 and 1860 (*Brit. Med. Journ.*), Krönlein in 1872, and the Moscow Surgical Society in 1877, have given their respective experiences and recommendations in regard to this method of dressing.

Von Kern's practice consisted in freely exposing the wounded surfaces to the air and simply keeping the edges of the wound in position by means of sponges. Vezin applied no kind of means for uniting wounds. Burow used sutures, but in such a way that they could be readily loosened in case of distension. Professor Humphry wrote:[1] "It is well known that wounds of the face commonly heal up in their whole length by first intention. This is due, in great measure, to the vital qualities of the parts, and in some degree also, I apprehend, to the fact that they are usually left exposed to the air, their edges being held in contact merely by sutures. For some years we have adopted this plan after amputations and all, or nearly all, other operations. The integuments are united by sutures placed at intervals of about an inch, and the wound, as well as the adjacent surface, is left quite exposed to the air, no plaster, bandage, or dressing of any kind being placed upon it. All the irritation, the galling pressure, the retention of heat, and other inconveniences resulting from bandages and plaster are thus avoided. The edge of the wound and the surrounding skin being uncovered, the eye can take cognizance of what is going on, and we can cut a stitch here and there when required, can keep the part clean, or take other measures, without difficulty. Forasmuch as no dressings are applied, there are none to be removed. The suffering which used to be caused by the dressing of wounds after operations is got rid of. In many cases I do not touch the wound, except for the purpose of removing the sutures, from the day of the operation." We decidedly have more frequent union by first intention than when we were in the habit of applying dressings to the wounds. If suppuration takes place, an early and free vent should be afforded to the pus by cutting the stitches and opening the wound; and care should be taken to keep the wound clean. "Large open wounds—that is, where portions of the skin have been removed, so that the edges cannot be approximated—are in our hospital (Cambridge) not unfrequently left exposed to the air without any covering. A dry crust or scab forms upon them, beneath which cicatrization goes on, and we find that the healing often proceeds more quickly in this way than when the part is kept moist and the products of the wound are continually flowing away into the dressings."

Krönlein tells us, after analyzing six thousand cases, that the open method has proved superior to all others, and demonstrates that the mortality of amputations, which

[1] Humphry, *British Med. Journal*, October 27, 1860.

by former methods had been fifty-one per cent., fell by the open treatment of wounds to twenty per cent.; and Rose, who is the present director of the clinic at Zurich, follows Krönlein. He exposes all his wounds to a fresh current of air, which is maintained by means of open doors and windows. He regards stitches and bandages of all kinds as interferences to be avoided, and trusts to *absolute rest* of the part after *careful arrest of bleeding*, to provision for thorough *drainage*, and to *scrupulous cleanliness*. The wounded limb after an amputation is kept in one position on a cushion so protected by mackintosh that the discharges may easily escape into a vessel placed to receive them.

Some of the practitioners of this system are somewhat inconsistent, since they advocate the frequent ablution of the exposed wound with carbolic water, or its protection by pouring over it the balsam of Peru; and C. Thiersch adds that whether the wound lies quite free, or is covered with a piece of oiled silk, or with a water compress, cold or warm, does not appear to be of importance if only free escape of the secretions is not affected thereby; we may also, he says, add irrigation without changing the character of the dressing, as practised by Bardeleben, and the permanent water-bath may also be of use. Thiersch, moreover, adds that in cases of compound fracture and gunshot injuries —since the free escape of secretions is one of the most important points in their treatment—wounds may be enlarged by incisions, abscesses opened, counter-openings made, and even free openings into wounded joints or resection practised.

The conclusions of the Moscow committee are also favorable to the practice, and may be condensed as follows: The essential feature of treatment by *aëration*, as this committee calls it, consists in avoiding all local appliances for excluding air, and in placing wounds in conditions favorable for free and direct contact with the atmosphere. Lint and other such substances should never be used. Repair by primary union should always be sought for when possible. Catgut ligatures and metallic sutures should be employed. The advocates of this system believe that the "Lister dressings" are injurious, but that the antiseptics employed counteract the baneful effects of the coverings.

Summary.—The results of this open treatment are evidently satisfactory, and, judged by the essential points to which attention has been directed, the open treatment of wounds may be advocated, for it includes careful adaptation of parts after arrest of all bleeding and due provision for thorough drainage; but, on the other hand, it takes little care to guard against mobility of the wounded parts and disregards antiseptic applications and precautions.

The neglect is, however, probably due to the justifiable impression that if drainage be provided for there will be, in the deeper parts, no retained dead tissues or fluids to decompose or undergo chemical change, and that a free current of air upon the surface of the wound is the best guarantee against septic changes of its fluids. Indeed, Professor Humphry clearly indicated this when he described how large open wounds by this system heal more quickly than when the part was covered and kept moist.

Some of the advocates of this system believe the open treatment to be more adapted to wounds in which union by *secondary* adhesion is to be expected, since they assert that if an open wound be maintained in a condition of perfect freedom from all irritating causes, such as foreign bodies, dirt, and decomposing elements, granulations will form, and that suppuration is not an essential part of their formation.

For my own part, after a careful review of the whole question, I must regard the open treatment of wounds as being far superior to any other in which due provision is not made for perfect drainage; but at the same time I fail to see its advantages over some others, and more particularly over that which I adopt, in which all the advantages of the open system are secured, and in which, in addition, the wounded part is effectually guarded against mobility and external injury, while at the same time due provision is made by means of a light antiseptic dressing against the possibility of any septic changes taking place at the surface as well as in the deeper portions of the wound.

The recent investigations of Pasteur[1] tend greatly to support the advocacy of this open dressing, since he claims to have proved "that it is the oxgen of the air which weakens or extinguishes germ virulence." Pasteur's experiments confirm those of Dr. Downs and Mr. Blunt obtained in 1877, and those obtained by Tyndall in 1881, whereby the influence of sunlight in arresting the development of bacteria was shown.

The treatment of wounds by "*irrigation*" must be regarded as only a variety in form of the open treatment, since its essential advantage consists in the cleansing and thorough draining of the wounds of all secretions and impurities. The mode of carrying out this method will be described under the heading "Water Dressing."

[1] *Acad. of Med., Lancet*, November 6, 1880.

In gunshot wounds of limbs and in sloughing or unhealthy stumps or wounds this mode of treatment by irrigation is very satisfactory. It has been employed at Guy's Hospital for a quarter of a century, and can be recommended. Esmarch speaks highly of it in military surgery.

On Water Dressing with and without Antiseptics in Solution.

In 1825 the late Mr. Syme published a paper in the *Edinburgh Medical and Surgical Journal*, July, in which he pointed out the evils of such old methods of dressing wounds as those of mundifying, digesting, incarning, and cicatrizing, and recommended that wounds should be lightly dressed with wet lint or other simple dressing after their edges had been adjusted and well brought together by stitches. To this surgeon, in connection with Mr. Liston, may be probably attributed the introduction into British surgery of the use of water dressing for wounds generally.

The practice was very rapidly taken hold of and adopted, every thoughtful surgeon having recognized the evils that attended the methods in which wounds were smothered with masses of charpie, lint, or other material, and left to heal as best they could under cover of such dressing saturated with blood, serum, or pus.

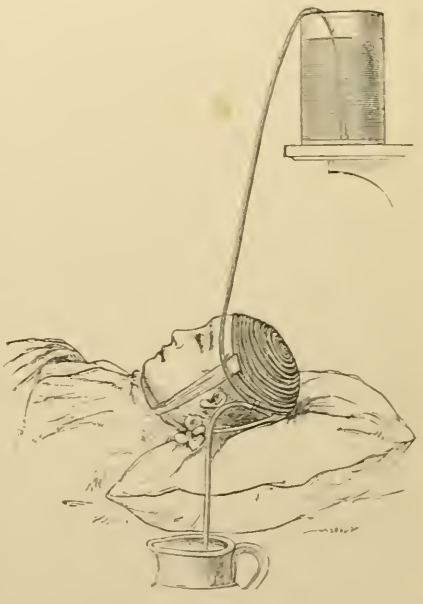
The practice, moreover, was simple and cleanly, and when perfected was comfortable to the patient to whom it was applied—that is, it became so as soon as the value of a piece of oiled silk or thin gutta-percha tissue, applied over the wet lint, was recognized, the wet lint without this addition having soon become dry, and what might have been at first a wet dressing became thus converted into a dry one.

The water dressing likewise soon took the place of poultices, for by one, as by the other, warmth and moisture were applied to the wound.

In 1835, ten years after the publication of Syme's paper, M. Josse, a hospital surgeon of Amiens, published a book on the use of cold water in surgical dressings, and advocated its use—*first*, as a trustworthy and efficient means for the control of inflammation in parts not wounded; and *secondly*, as a dressing for wounds.

"If we had the choice," he says, referring to the treatment of the first class of cases in which there is no wound, "it might be established as a general principle that we ought to employ water by affusion with a continual stream, but the nature of the parts or of the disease may prevent this and oblige us to recur to another method: thus, linen moistened with water and renewed without ceasing may to a certain degre prove a substitute for the affusions, but this mode requires much attention." He subsequently describes his own method: "A vessel with a cock near its base is filled with water and placed upon a narrow and high table, near the patient's bed, in such a position that it shall be about a foot and a half above the diseased limb, beneath which a cerecloth is spread, intended to guard the bed and facilitate the flow of the water, which is received in a bucket placed near for that purpose, and into which the extremity of the cerecloth descends. The diseased part should then be placed in the most convenient position; it should be lightly covered with compresses; an additional piece of linen should surround the cock by one of its extremities, while the other is extended over the highest point of the apparatus. This is designed to prevent the water from falling with all its weight on the diseased part, and rather to disperse it over a larger surface."

Fig. 9.



I have described this method of using cold water fully, for it is one now recognized as the treatment by "irrigation," which, whether employed as cold affusion to check inflammation in injured parts, as in joints, or to keep wounds clean, is of great value.

M. Josse likewise declared "that when cold water is applied directly after the injury, before reaction has taken place, and where it can be maintained with energy proportionate

to the occasion, the phenomena of reaction will be prevented; heat, pain, and swelling will be subdued, and, consequently, sympathetic fever will not take place; but when the cold has not been applied before the development of the inflammatory symptoms, they will still be conquered by its efficient use." In these opinions most surgeons will agree; but cold is not now often employed in the manner described, the introduction of ice and ice-bags having led to the adoption of simpler and more effective methods of application. The metallic coil of Leiter of Vienna is probably the best method of applying cold. I have used it freely, and like it much. It seems to embody in itself all the advantages, without the disadvantages, of all other known methods of refrigerating a part. It is also equally valuable for the application of heat (*vide* Fig. 9).

But, however valuable cold-water compresses or bandages, hot fomentations, or a warm-water dressing may be as applications to parts that have been injured, bruised, or inflamed, they cannot be strongly recommended as dressings to parts in which wounds exist; for it is now a fairly well recognized fact that water, *per se*, helps better than anything else to encourage in an injured or half-dying tissue, as well as in the secretions of a wounded part, chemical and fermentative changes by means of which septic poisons are generated or made to flourish, and from the absorption of which blood poisoning is known to follow.

Water holding some antiseptic substance in solution may, however, be used, the antiseptic preventing or neutralizing the septic changes which the water by itself might encourage.

In wounds, therefore, that are much complicated with contusion and laceration of parts, and to which hot or cold fomentations seem applicable, these medicated-water dressings may be employed, it being left to the fancy of the surgeon whether he shall use carbolic acid 1 in 20 of water, boracic acid 1 in 50, salicylic acid 1 in 50, thymol 1 in 1000, iodine tincture 1 in 80, or iodine liquor 1 in 160, or permanganate of potash 1 part to 50.

Value of Oily Dressings.—For my own part, I have for years given up using water as a dressing for wounds, whether with or without antiseptic substances, for I have found that oily solutions of the same substances have advantages over the watery preparations which render them far safer and more satisfactory. Oily antiseptic applications are without doubt the best dressings for wounds which we possess, and of these one composed of terebene one part and olive oil three or four parts deserves, as already mentioned, the preference.

The Dry Dressing of Wounds.

A dry dressing to a wound is to be preferred to one of which simple water forms a part, since with it the sanguineous or serous exudations are more or less absorbed and rendered inert, and the surface of the wound is kept quiet and protected as by a scab from outside injurious influences; whereas with a water dressing the injured surface of the wound and the wound-exudations are encouraged to undergo chemical and fermentative changes by which the risks of absorption of septic matter or poison are much increased and the dangers of the simplest wound greatly enhanced.

If the dry dressing be composed of some absorbent material, such as the absorbent cotton or lint, and impregnated with an antiseptic substance, such as boracic or salicylic acid or iodoform, its efficacy will be increased, since the dressing, under these circumstances, may be left untouched for some days, even for a week, and the healing of the part will not, therefore, be interfered with. Repair, as a consequence, will go on with greater rapidity and certainty, the secondary wound dangers will be diminished, and the ultimate issue of the case will be rendered more satisfactory.

When a wound is *small* and the surgeon has no doubt as to the propriety of seeking to obtain its immediate union, the dry dressing can be recommended; for it, without doubt, helps better than any other to bring about the "quick union" which is wanted.

When the wound is *large* or *deep*, the same recommendation cannot be made, and the dry dressings, if used, should only be so after every care has been taken to provide for the free drainage of the part. They should, moreover, only be employed when there is a reasonable hope of the parts healing by primary union.

When a wound is *much lacerated* or *contused*, dry dressings are not applicable, since in such no surgeon would entertain the thoughts of repair being brought about by rapid union; and where this hope cannot reasonably be entertained, the use of the dry dressings should be discarded. In brief, in all wounds, small or large, when repair by "quick union" may reasonably be looked for, dry dressings are applicable, due provision having

been made for efficient drainage. In all lacerated, contused, or deep wounds in which repair by granulation is to be expected, these dressings are not to be recommended.

Earth Dressings.

Earth as a dressing for wounds has doubtless been used by savage nations from an early period of the world's history, but it was first brought before the notice of surgeons by Dr. Addinell Hewson of Philadelphia, United States, in 1872, and from his work upon the subject it seems that he first resorted to this mode of treatment in 1869. Dr. Hewson was first led to employ the earth as a deodorizer in a bad example of compound fracture of the leg, and, as the result in this case was good in all respects, he began to employ it as a primary dressing to wounds. The earth used by Dr. Hewson was dried yellow ferruginous clay which had been well sifted through a fine flour-sieve, and he claims for its use many advantages. He maintains that it is "cool and pleasant" to the patient as a local application, and that it has a marked influence in soothing pain. In burn and in carbuncle cases this relief is very striking.

Dr. Hewson has satisfied himself that earth, besides being a deodorizer, has a marked influence in preventing putrefaction; that in no case does it provoke or aggravate inflammatory action in a wound, but that in many it retards or arrests it; and, above all, that it promotes the healing process in wounds of every description, as well as in ulcers. The way in which the clay acts as a dressing may not be clear, but it seems reasonable, from the evidence adduced by Dr. Hewson and others, to conclude that it has by its powers of absorbing gases, and more particularly ammonia, a chemical action upon the part to which it is applied, and that by virtue of this action it is "an efficient means of delaying decay and putrefaction, and of preventing fermentation in animal tissue." Besides this, it excludes air from the wounded tissues, absorbs moisture and excess of discharges, and helps in a measure to give support to wounded parts.

The dressing is applied directly to the wounded or ulcerated surface by dusting over it the pulverized clay, or in the case of a stump by placing it upon a bed of dry clay in a box extemporized of binder's board, and by completely covering in the whole surface by some more clay. In some cases, when the clay becomes saturated with discharge, the dressing has to be renewed daily; in others, it may be left for two or more days.

Upon the whole, this mode of practice has not extended far beyond the sphere occupied by its originator, and it does not seem to possess any advantages over the more cleanly and simple processes which are now at the disposal of surgeons. Some years ago, when Dr Hewson was in London, I was tempted to give the method a trial, but I soon gave it up, as experience was not in its favor. The dirtiness of the dressing was not compensated for by any advantage. This, however, may have been because I was unable to obtain the right kind of ferruginous clay.

Alcoholic Dressing of Wounds.

Hippocrates, Paracelsus, and others employed wine as a dressing to wounds, and they did so under the idea that it dried the part, and with the belief that a dry condition was nearer a state of health, whilst humidity was nearer that of disease. Their followers used wine in which astringents were dissolved, such as gall-nuts, oak-bark, etc. All did so, moreover, with the view of arresting bleeding. In more recent times the alcohol dressing has been made popular by Nélaton, who used it largely and found it of value. It may be applied in the form of simple alcohol, or, which seems preferable, in that of the camphorated spirit of wine, as originally used by Dionis.

The dressing is said to be a coagulant and astringent, and, with such properties, to favor primary adhesion. In open wounds it is said to act as a healthy stimulant to the granulations and as a disinfectant, thus helping repair and guarding against septicæmic changes and other wound complications. Nélaton employed compresses saturated with alcohol, and he believed the camphorated spirit to be useful only in proportion to the alcohol it contained.

M. Chédevergne asserts "that camphorated spirit of wine is, without contradiction, the best disinfectant that can be found for the treatment of wounds and ulcers;" and he makes this statement after a careful investigation into the value of every known antiseptic, not excluding carbolic acid. The spirit is supposed to have the power of dissolving the pus cell, of obviating its tendency to decompose, and of closing any open vessels.

Maisonneuve bathes the raw surface of the wound with the spirit, and, having

brought the divided edges together and adjusted them with sutures or adhesive plaster so placed as to allow of the free escape of discharges, envelops the whole in a bandage steeped in tincture of arnica, and at times he applies over the whole the apparatus for "pneumatic aspiration," which will be again referred to. The disinfecting and cleansing power of the spirit, applied in this manner, probably helps the draining influence of the aspirator.

Upon the whole, the alcohol dressing may be favorably regarded, whether simple alcohol or spirits of camphor be employed. It has, without doubt, a cleansing, and probably a disinfecting, influence on a wounded surface; while, at the same time, it helps materially to arrest capillary bleeding and that serous oozing which is so detrimental to primary union. In its use, however, the surgeon should never be induced to forget the value of the other essential points of practice to which attention has been drawn, and particularly drainage.

Pneumatic Aspiration or Occlusion.

Maisonneuve's method of "pneumatic aspiration," which he employed with some success before 1867, and J. Guérin's plan of effecting "pneumatic occlusion," promulgated in 1865, were practised thus: Assuming an amputation of the thigh to have been just performed and the vessels secured, the edges of the wound are brought together and held in apposition with adhesive plaster, but without sutures. A hood of vulcanized india-rubber is then passed over the stump several inches—a foot, if space allows—from the extremity. It is essential that the aperture of the india-rubber cap should fit the limb accurately, but the crown or lower part may hang some distance from the wound. To the centre of the crown of the india-rubber cap is attached a tube of similar material about two or three feet long, fitted by its opposite extremity, through a metallic canula, in a rubber plug, which fits into a gallon glass jar. A second metallic tube pierces the india-rubber plug and is connected with another vulcanized tube of convenient length attached to a brass exhausting-pump. A few strokes of the piston morning and evening suffice to draw the discharges from the stump into the jar, where, in the absence of air, they accumulate without danger of decomposition; while the healing of the wound is facilitated by the accurate and immovable adaptation of its surfaces and the exclusion of air. This practice of Maisonneuve's has three main objects in view, all of which are good—first, to check the formation of matter; second, to prevent its decomposition when formed; and third, to prevent its poisonous action on the system by entrance into the circulation. It is essentially based upon the principle of "drainage," and in that point of view is valuable. In exceptional cases, and particularly in certain cases of amputation, it may be employed, but as a general mode of treating stumps it does not appear to possess such advantages over simpler methods as to make up for the difficulties and expense of its employment.

Antiseptic Irrigation of Wounds.

The value of the antiseptic irrigation of wounds is not at the present day likely to be disputed by any surgeon, and a difference of opinion is only probable as to the antiseptic which shall be used, the mode of its application, and the character of the wound to which it is applicable. Every surgeon seeks to make and to keep his patient's wounds as clean as possible and by means of antiseptic solutions or applications to destroy, neutralize, or guard against any and every outside or local influence that can possibly bring about or encourage chemical or fermentative changes in a wound. It is true that within the last few years a school of surgeons has been formed the members of which talk of "antiseptic surgery" and claim for themselves the title of "antiseptic surgeons," as if it were applicable to themselves alone, or rather to such of their body as have a belief in the germ theory as a cause of most, if not all, the surgical ills to which wounded flesh is heir, who assert rather loudly and dogmatically that "antiseptic surgery" must stand or fall with the theory upon which their practice is based, that no unbeliever in the theory is likely to carry out the practice with any probability of success, since it is only by a staunch believer in the theory that care and attention to every detail of treatment sufficient to bring about a good result is likely to be given. It is true, also, that the results claimed for this practice are great—very great, beyond all previous belief; that, according to these gentlemen, operations which in former times were looked upon as dangerous can now be undertaken with a "*certainty*" of success, and that others which have hitherto been regarded as unjustifiable are now legitimate and safe. In fact, the upholders of

this theory and adopters of this practice maintain that exploratory and operative measures which have been regarded as being beyond the province of the surgeon may now be calmly and quietly undertaken with a "*moral certainty*" of being followed by a good result. Thus it is that our sanguine *confreres* talk of cutting into healthy joints with the "*certainty*" that no danger will follow, and declare that great operations upon the bones of the knee may be undertaken with the feeling that in so doing we do not subject the patient "to any risk whatever;" that a wedge-shaped piece of bone may be taken from a deformed femur with the confidence that so produced a compound fracture is "perfectly safe" and "without risk;" and last, but not least, that the peritoneal cavity, under antiseptic precautions, may be opened "*with impunity*."

I need hardly say that much of this is bold assertion and nothing more, and that it is apparently due to the sanguine temperament which seems attached to those who pin their faith to a taking theory and adopt the practice which is based upon it in blind deference to the authority of its distinguished originator; for facts, calmly looked at, neither by their number nor by their weight justify these conclusions, but irresistibly suggest that an enormous superstructure has been raised by the ingenuity of its builders upon a narrow foundation, and that good results have been too hastily attributed to causes which have been but some of the factors of a work to which others equally potent for good have, without doubt, contributed.

Facts, indeed, have been employed by our self-styled "antiseptic" friends, as legal advocates use small data which tell in their favor, to support the cause they have in hand, but not as the judge who has to weigh evidence and with an unbiased mind give judgment. It is only by this explanation that we can understand how the "antiseptic surgeon," when he gets a good result, is so fond of asserting that such could not have been brought about by any other form of practice than that which he adopted, and when he is attempting an operation which may in all truth be called experimental, if not rash, maintains that he undertakes it "*under the spray*" with all confidence and with a "moral certainty" of meeting with success. We must admit, however, that surgery is now much more successful than it was twenty years ago, and that of the many factors which have brought about this result the employment of antiseptics stands foremost; and if we are not altogether indebted to Mr. Lister for their use, we are unquestionably indebted to him for the able and persistent manner in which he has both advocated their employment and demonstrated their value. All honor, therefore, to the name of Lister for having helped more than any one else to establish the value of antiseptic drugs and antiseptic precautions in the practice of surgery all over the world. Let those who smile at his theory join with those who believe in it in giving him this just meed of praise, and let those who do not believe in the efficacy of the "spray" do their best to prove to those who do that all the advantages of the "antiseptic system" can be obtained by simpler means than by its use.

Among these means what must be called "antiseptic irrigation" of wounds, in my judgment, stands foremost. Antiseptic irrigation means the washing of a wound with an antiseptic solution with the view of destroying any and every germ or element that might possibly set up chemical or fermentative changes in its secretions. It is as applicable to fresh wounds, accidental or operative, as it is to the suppurative or foul, and it is as valuable as a preventive as it is as a curative means.

In my own practice the solution employed is, as has already been mentioned, iodine water—that is, a mixture of the tincture of iodine and water in the proportions of 1 part to 80, or of the liquor 1 in 160—and after operations this should be applied hot. It may be used by means of the irrigating-bottle as drawn at page 33, Fig. 3, or by means of sponging. Where sponges are employed they should be well soaked in this fluid, and subsequently, before the wound is dressed, should be used to absorb all excess; for this lotion, when employed warm, has more power than any other of which I know to check capillary bleeding, and to bring about that desirable "glazing" of a wounded surface which is so valuable as a first step toward quick or rapid repair. In suppurating wounds the same lotion cleanses better than anything else, and has the power of destroying germs of evil as well as other more vaunted germicides. For the irrigation of a chronic abscess or sinus it is equally to be advocated; indeed, as a purifying and antiseptic lotion for all wounds of external parts, as well as for all suppurating cavities, it can be highly recommended. I have employed it for years past as a purifying agent, but without germicidal intentions, with excellent results; and, although I have seen much of the spray and carbolic-acid practice, I cannot yet see that its results are better than my own. Those who prefer carbolic acid as an antiseptic can use it in the same way in the strength of 1 in

30 or 40, and thymol, boracic acid, chloride of zinc, oil of eucalyptus, or any other known antiseptic, may be similarly employed.

The essential feature of the practice consists in the thorough ablution of the wounded or diseased part with the antiseptic solution after the arrest of all bleeding, the drying of the surface of the wound as far as possible with an antiseptic hot sponge applied with moderate pressure, and subsequently the careful dressing of the wound with some antiseptic substance in the way that was described in an early page ("Protection of Wounds").

The Listerian Method of Dressing Wounds.

This method is founded on the theory that the fermentation of the discharges of wounds is due to the introduction into them from without of

> "those viewless beings
> Whose mansion is the smallest particle
> Of the impassive atmosphere,"

now known as micro-organisms or bacteria. The practice, which is based upon the theory, is framed solely and wholly with the view of destroying those aërial enemies by means of the familiar cloud of carbolized spray (1 in 40) *before* they reach the wound, and by the carbolic solution (1 in 20) when they have alighted on or entered it, the green protective gauze, carbolized catgut, and other paraphernalia being employed with the object of guarding against the introduction of the same dangerous foes during the subsequent progress of the case.

This method, which at its birth was named "antiseptic," is now designated "the aseptic," but the change is not acceptable, since it contains an assumption of superiority of "the Listerian" over other forms of good antiseptic surgery when the object of all is the prevention, exclusion, and destruction of the causes of fermentation in wounds.

The sponsors of the new term have evidently forgotten that Pasteur has proved that "it is the oxygen of the air weakens or extinguishes germs;" that Downes and Tyndall have shown that "sunlight arrests development of bacteria;" that Lister has admitted "the probability that putrefaction in wounds is due rather to the septic matter in a concentrated form than to the diffused condition in which it exists either in water or in air;" that the spray is, beyond all question, the least important of our antiseptics; that bacteria are unable to grow in normal serum and can only develop in that liquid when it has been vitiated, whether by the addition of water or by the action of small quantities of the acrid products of putrefaction;" and last, but not least, "that the tissues of a healthy living body have a power of counteracting the energies of bacteria in their vicinity and preventing their development."

The surgeon who adopts the method must "act as if all the particles made visible by a sunbeam were noxious, falling like snowflakes during every operation and every dressing, seeking to insinuate themselves into the wound at every crevice. His aim should be to destroy the intruders and effectually exclude their thronging companions."

To do this, the *skin of the patient* over and in the neighborhood of the intended wound should be thoroughly washed with carbolic water (1 in 20), which must be allowed to act for some little time, because the antiseptic has to mix with the fatty matters and to penetrate into the folds of the skin, and the micro-organisms may be peculiarly resistant. The *hands of the operator* are likewise to be cleansed with the same lotion, special care being observed with the nails and the folds of skin about them. For the *purification of the instruments* a porcelain or tin trough is provided and filled with the 1-20 solution, and into this the instruments to be employed should be laid for at least half an hour before the operation.

"The *sponges* are washed in the 1-40 carbolic solution. After the operation they are rinsed in water and then placed in a jar of 1-20 solution till required again; then the 1-20 solution is squeezed out, and the sponge, when washed in the 1-40 lotion, is ready for use. These sponges may be used for a long time—till, in fact, they wear out. In some cases they get clogged with fibrine. To get rid of this, the sponge is placed in a trough containing water and left for some days. The fibrine putrefies, and can then be washed out readily. The sponge is then placed in a jar containing the 1-20 carbolic lotion, and is ready for use when required."[1]

[1] From W. Watson Cheyne's able article in Ashhurst's *International Encyclopædia of Surgery.*

"The *purification of the air* is effected by means of a spray of carbolic acid. The spray is produced by driving a rapid current of air through the narrow orifice of a horizontal tube, which is placed over the orifice of a more or less vertical one. The air, rushing over the opening in the vertical tube, sucks the air out of that; and if the lower end dips into a fluid, the fluid is sucked up and expelled from the narrow orifice in the form of finely-divided particles or spray. At present steam sprays are employed. The fluid in the retort is 1-20 watery solution of carbolic acid, and this mixing with the steam from the boiler, forms a spray of about 1-30. The spray is employed during the whole operation—till, in fact, the dressing has been securely applied.

"The operation having been performed with the precautions detailed, the *hæmorrhage must be arrested*. This is done by means of ligatures of carbolized catgut. There are two kinds of catgut which are at present employed—the carbolized catgut,[1] which was that first introduced by Mr. Lister, and the chromic-acid gut,[2] which lasts longer in the tissues than the former and is more rapidly and easily prepared. All bleeding points are tied, and the ligatures cut short. There is no excuse for leaving any bleeding vessels, as the ligatures cause no trouble afterward."

"With the view of excluding organisms *after the operation*, the material usually employed is the carbolic gauze. This is ordinary tarlatan impregnated with a mixture of one part of carbolic acid, four parts of resin, and four parts of paraffin. If the cotton material were merely dipped in carbolic acid or carbolic lotion, the antiseptic would very quickly volatilize or be washed out by the discharge. It is necessary, therefore, to have the antiseptic stored up, so that it may last for some time. This is the purpose of the resin. Resin and carbolic acid have a much greater affinity than water and carbolic acid. Water, therefore, may pass over a mixture of resin and carbolic acid for a considerable time without washing out all the antiseptic. If the gauze were impregnated with resin and carbolic acid alone, it would be so sticky as to be useless; and therefore paraffin is added to it in sufficient quantities to do away with its stickiness. As the gauze at ordinary temperatures does not give off much carbolic acid, dust which falls on it is not deprived of its fermenting property; and if a piece of gauze covered with dust is applied over the orifice of a drainage-tube, this dust may pass into the wound and entirely defeat the object of the whole treatment. On the other hand, the watery solution of carbolic acid acts very rapidly, and hence all that is necessary is to dip the layers of the gauze which go next the wound in the 1-40 lotion. Lest the carbolic acid should evaporate, the gauze, if it is to be kept for some time, is preserved in closely-shutting tin boxes.

"Carbolic acid is a powerful irritant, and applied directly to a wound it will retard, or even prevent, healing. With the view of overcoming this difficulty, Mr. Lister interposes a material impervious to carbolic acid between the wound and the gauze dressing. This material is termed the *protective*. It is ordinary oiled silk coated on both sides with a thick layer of copal varnish; outside this a solution of dextrine is brushed, because water runs off from the material without the dextrine just as from a duck's back, whereas the dextrine dissolves in the lotion and the protective is equally and perfectly moistened. This protective is cut a little larger than the wound, dipped in the lotion, and applied over it. Outside the protective we have the wet gauze, larger than the protective and overlapping it in all directions, both together being called the 'deep dressing.'

"When used as a dressing, the carbolic gauze is packed into the hollows around the wound, and then a regular dressing is applied. This consists of the gauze folded in eight layers, beneath the outer layer of which is placed a piece of mackintosh cloth—what is known as hat-lining. The object of this is to make the discharge traverse the whole of the dressing and not pass directly through, as would be the case were the mackintosh absent. If there were no mackintosh, the discharge, always passing through one part, would wash out all the antiseptic in a very short time, and putrefaction would rapidly occur. To avoid this risk a large quantity of gauze would be necessary, and this would increase the expense of the treatment very much; whereas by the use of the mackintosh the discharge is made to pass from the centre to the edge of the dressing—that is, through a mass of gauze equal in thickness to the distance from the centre to the edge of the dressing. The same piece of mackintosh may be used several times—till, in fact, it wears out. After the dressing has been removed it is taken out, sponged with carbolic lotion, and introduced into the new dressing. Thus, though an expensive material, when divided over a number of dressings, its expense becomes very little. Expense is also saved by preserving the large pieces of gauze used in the dressings. They may be

[1] *Lancet*, April 3, 1869. [2] *Ibid.*, February 5, 1881.

washed and recharged with the carbolic-acid mixture. These dressings should be large, and should overlap the wound for a considerable distance in every direction.

"The dressing is fastened on by a bandage. This may be made of carbolic gauze, which is light, cheap, and useful in many ways. But a cheaper bandage, and one sufficiently convenient—indeed, more convenient than the carbolic-gauze bandage in many ways—may be made of thin muslin. As the dressing may not remain closely applied to the skin during all the movements of the patient, more especially in the neck, chest, or groins, there is a certain risk that air unacted on by the antiseptic may pass under the dressing and reach the wound, carrying active septic dust along with it. This danger is obviated by applying an elastic bandage along the edge of the dressing. This may be put sufficiently on the stretch to keep the edge of the dressing accurately in contact with the skin without pressing injuriously or interfering with the circulation in the part. Pins are put in along the edge of the dressing, fastening the dressing and the bandages together at the important points. Safety-pins are the best for the purpose, as common pins are apt to get buried and lost in the gauze."

In accidental wounds, to extirpate the germs, the wound should be washed in and out with the 1-20 carbolic lotion, a syringe being employed in a case of compound fracture or gunshot wound. "Care must be taken to have the external wound freely open, so that the injected fluid may escape readily; for otherwise there would be a danger of the fluid penetrating among the layers of the cellular tissue and causing inflammation, or even gangrene. It is well to squeeze out all the blood clots."

During an operation the surgeon should have spread near him towels saturated with the 1-20 carbolic lotion, upon which to place all instruments he may be using; a basin, containing the 1-40 solution, should likewise be at hand to enable the surgeon to purify his hands and instruments should they have been contaminated with septic dust. All instruments and sponges should be handed through the carbolic spray.

The surgeon should know, however, for his comfort, "that there are comparatively few particles capable of causing fermentation in ordinary air," that "where no spray is at hand the aseptic method may still be carried out, and that the spray is the least essential part of the method as at present employed. The most essential part of the treatment is the thorough purification of everything which comes in contact with the wound. The introduction of an unpurified instrument into a wound is a much worse error, and one far more likely to be followed by bad results, than the momentary deflection or cessation of the spray."

"The dressing is always changed on the day following the operation, and afterward the rule is that, if at the hour of the ordinary visit discharge is found at the edge of the dressing, it is changed; if not, it is left till the next day, when the same rule is followed. The dressing is never left longer than a week unchanged. In changing the dressings the spray is used."

If the surgeon does not have a spray at hand for the purpose of changing the dressings, and it is necessary to expose the wound, it is pleasant to be told "that it is well, by means of a syringe, to let a current of carbolic lotion flow over it when it is exposed."

In fact, it may now be said that the Listerian mode of dressing has had its day, though the principle upon which it is based survives, and is likely to do so. The antiseptic irrigation of wounds, as considered in the previous section, is simpler and equally effectual.

Subcutaneous Wounds.

When John Hunter, in 1794, in describing injuries, divided them into those in which the injured parts do not communicate externally, as sprains, bruises, simple fractures of bones, or divisions of tendons, and those which have an external communication, as compound fractures and wounds of all kinds, and laid it down as a law that the injuries of the first class seldom inflame, whilst those of the second commonly both inflame and suppurate, he established a principle of which, "indeed, it seems hardly possible to exaggerate the importance" (Paget), and laid the foundation of a branch of surgical practice now known as *subcutaneous surgery*. Why it is that extensive injuries to soft parts, when covered with skin, should undergo quiet and thorough repair with little or no constitutional disturbance may not be clear, but daily experience teaches us that dislocations of large joints, fractures of bones, severe contusions and lacerations of soft parts associated with copious local hæmorrhages, and even crushes of all the subcutaneous tissues of a foot or hand, as a rule, do well provided that they are not interfered with by meddle-

some practice, but are placed in the most favorable position for natural repair to carry out its silent work; whereas the same experience tells us with no uncertain voice that the presence of a wound, however small, may change matters all round and turn an injury which, had it been subcutaneous, might have been regarded as trivial into one of a serious and complicated kind. This fact is well exemplified in the different course usually taken by a simple and a compound dislocation or fracture.

What there is in the air that makes this wide difference is now, as it ever has been, open to argument; and whether it is the stimulating or chemical influence of the oxygen, the irritating influence of atmospheric germs, the length of time the part is exposed rather than the mere fact of exposure, or some other cause, may be subject of dispute. In modern times the germ theory has found much favor and has been the fashion, and attempts have been made to assign to the presence of germs every evil influence, and to regard them as the cause of inflammation and suppuration in every open wound. But this view can hardly be sustained; for, on the one hand, even in subcutaneous injuries, in which no air can get in, inflammation and suppuration may ensue, while, on the other hand, in even severe examples of fractured ribs complicated with emphysema over the chest, body, head, and extremities—in cases in which the whole cellular tissue of the body seems infiltrated with unfiltered air under most unfavorable circumstances—it is quite exceptional for any inflammation of the infiltrated parts to take place. Indeed, I may say that I have never seen an instance in which it occurred.

Effects of Injection of Air into Tissues.—As corroborative evidence I may refer to some observations made in 1857 by Malgaigne, who, to test this question, made animals emphysematous with common unfiltered air and then fractured their bones, divided their tendons, and opened their joints *subcutaneously:* though the parts operated upon were surrounded with air no inflammation followed. I may refer also to the experiments of Wegner (*Langenback's Archives*, vol. xx.), who injected air derived from the post-mortem room into the subcutaneous tissue of rabbits with impunity.

For my own part, I am disposed to think it is not the mere exposure of a wounded part to the influence of air that does the harm, but its prolonged exposure, since it is certain that where wounds are sealed rapidly after the receipt of an injury, and are thus placed much in the position of subcutaneous injuries, repair goes on silently and well. Even bad compound fractures, when sealed early from the influence of air, heal, as a rule, like subcutaneous injuries.

Repair of Subcutaneous Wounds.—It may be accepted as a truth that subcutaneous wounds are repaired much in the same way as open wounds that heal by quick or primary union—that is, when the wounded hard or soft tissues are brought or kept in contact, they simply reunite. The process of repair in both cases is a quiet physiological one not unlike that of development and growth. The action that attends the process is just enough to bring about the required result, but no more. When it is excessive, inflammation is said to exist; and this inflammation, in subcutaneous as in open wounds, always prevents, checks, arrests, or undoes the work of repair. In truth, the less there is of inflammation in a wounded part, subcutaneous or open, the more perfect and steady is the reparative process. When inflammation takes place in the site of some subcutaneous operation, the process of repair is likely to be interfered with, if not arrested; for, as Paget observes, "the more manifest are the signs of inflammation, the less is the quantity of the proper reparative material, and the slower, in the end, is the process of repair."

To Paget and W. Adams in England we are chiefly indebted for our knowledge of this subject, and I shall use as much as possible Adams's description of this process, as published in 1860 in his work on the *Reparative Process of Human Tendons after Division*. His investigations have confirmed those of Paget, as well as added to our stock of knowledge.

Where tendons are subcutaneously divided and drawn asunder, their repair takes place as follows:

When such a tendon as the tendo Achillis is divided subcutaneously, the divided ends separate, in an infant for half an inch and in an adult from one to two inches, the degree depending much upon the healthy condition of the divided muscle and the amount of movement subsequently permitted in the ankle-joint.

The reparative process begins by increased vascularity in the sheath of the tendon, which is followed by the infiltration of a blastematous material into the spaces between the fibrous elements of the sheath. This material exhibits the development of innumerable small nuclei, a few cells of large size and irregular form, with granular contents, or,

perhaps, with one or more nuclei and studded with minute molecules of oil. A blastematous material in which the cell forms do not develop beyond the stage of nuclei appears to be the proper reparative material from which new tendon is developed. This nucleated blastema soon becomes vascular, capillary vessels having been seen in it on the eighteenth day; the nuclei assume an elongated, spindle-, or oat-shaped form, and are seen, after the addition of acetic acid, to be arranged in parallel linear series. The tissue becomes gradually more fibrillated, and at last fibrous, a solid bond of union subsequently forming between the divided extremities of the tendon. The uniting medium is tough to the touch, but to the eye presents, even for at least three years, a grayish, translucent appearance, distinguishing it at once from the glistening old tendon. This new tissue remains during life, and has little tendency to contract subsequently. Adams's observations rather led him to the conclusion that the required portion of new tendon is to be obtained during a lengthened period of formation—that is, about two to three weeks—under the ordinary conditions of health; but in paralytic cases, as in others of feeble health, this period may be doubled.

Adams informs us, also, that the divided extremities of the old tendon take no active part in the reparative process during its earlier stages, although at the later the cut ends become rounded and their structure softened. They become enlarged and exhibit a tendency to split, and thin streaks of new material similar to that already described are seen between their fibres; the ends are joined by these means. At a later period the bulbous enlargement gradually diminishes.

When a tendon is divided a second time, there is but little separation of its ends; and this is probably due to adhesion of the new tendon to the neighboring fibro-cellular tissue, in which fact is found an explanation of the unsatisfactory results of second operations.

There is no reason for believing that in the treatment of deformities by tenotomy direct approximation and reunion of the divided extremities of the tendon must first be obtained, and that the required elongation is afterward to be procured by gradual mechanical extension of the new connecting medium, as we would stretch a piece of india-rubber.

When much blood is effused between the divided ends of the tendon, it has to be absorbed; it acts merely as a foreign body in the part, and retards repair.

Treatment of Subcutaneous Wounds.

When rightly treated, these wounds are generally repaired readily, and, as Hunter asserted, without inflammation; but when not rightly treated, "the subcutaneous action of a wound is not of itself a sufficient protection against inflammatory complications, and a clumsily-performed subcutaneous operation may be as dangerous as an open wound—sometimes even more so" (W. Adams).

In the treatment of these as of open wounds there are, consequently, essential points of practice to be observed in order that good results may be obtained, and they are not unlike those which have been laid down for the treatment of open wounds—that is to say, the injured parts are to be placed as far as possible in a position of ease, and in which the contact of the divided tissues is assured when contact is called for. The parts are, moreover, to be fixed, by splints, bandages, or other dressings, in a condition of absolute immobility. The seat of injury is to be protected from all outside injurious influences and to be supported by moderate pressure, and, what is more, is to be undisturbed, in order that neither by manipulation nor movement shall repair be retarded; for a subcutaneous wound is as susceptible to injury from mechanical interference as is an open wound. In treating the wounds made by the operations of subcutaneous surgery the same principles of practice are applicable, and they are well summed up by Adams as follows:

The conditions requisite to render the subcutaneous operations exempt from inflammation are as follows: 1. That the knife used must be of small size; 2. That the operation must be performed quickly and readily, with decision rather than force, and with as little disturbance to the soft parts as possible; 3. That the wound must be immediately closed and a compress and bandage applied, so as to prevent effusion and to support the part; 4. That perfect quiescence to the part be ensured for three or four days, and the dressing remain undisturbed. When all these conditions are strictly observed, it matters little whether large muscles or tendons or ligaments are divided, or even whether the larger joints of the body are opened. From all this it is to be gathered that to the treatment of subcutaneous wounds, whether of accidental or operative origin, "position,"

"immobility," "pressure" to support the part, and "time" for repair to perfect itself, are the four essential requisites to be provided for.

Complications of Wounds.

On the well-founded assumption that a wound, when made into healthy tissues in a healthy subject, will heal by natural processes if placed in the most favorable position for repair and *not interfered with*, it cannot well be disputed, when a wound does not heal thus kindly, that there must be some obstacle or hindrance to its natural progress; and this will doubtless be found either in the nature of the wound itself, or the mode in which it has been treated, or in the peculiarities of the subject of the wound, or the surroundings of the case.

When the hindrance is due to the "*wound itself*" or to its "*treatment*," it may be that some foreign body has been left to irritate; that the hæmorrhage which ensued "primarily" on its receipt has not been effectually arrested, and that a clot has formed between the edges of the wound; that a "recurring" bleeding has taken place within a day or so after the infliction of the wound and its first dressing from some imperfection in the treatment of the bleeding vessel or from excessive reaction; or that a collection of serum has been allowed to form in the depths of the injured tissues. In most of these cases the causes of non-repair are clearly referable to a want of care or skill on the part of the surgeon who has had the early treatment of the case, and must be set down as preventable causes. By want of care the edges of the wound may not have been properly adjusted or kept in apposition, the injured limb may not have been made immobile, and as a result spasmodic muscular movements and jumpings of the limb may have been excited; or an insufficient provision may have been made for drainage, and, as a consequence, the wound may have been irritated by retained secretions, and possibly made to inflame by the "tension" which the retained secretions have produced. Harm may also have been brought about by the want of due attention to the dressing of the wound, and to its efficient protection from outside injurious influences. Other cause of non-repair may be the unsuitable character of the dressing used or the position in which the wound has been placed.

When the obstacle to natural repair exists in the "*subject of the wound*" or in the surroundings of the case, it may perhaps be found in the age, temperament, or feebleness of the patient, as expressed by deficiency in the healing act, excess of pain, or inflammation of the wounded parts, or, again, in the unhealthy atmospheric condition of the patient's chamber or residence, or in the unsuitable character of the patient's food, or in want of proper nursing. Under any circumstances, the obstacle to repair will be found in one or more of these causes, and it is for the watchful eye of the surgeon to discover the particular defect, in order that he may apply the proper remedy.

It is well, however, for the student to recognize the fact that most of the causes of want of repair are preventable, and that they are, as a rule, due to some want of care in the primary dressing of the wound; let it be repeated, therefore, that in all cases and under all circumstances too much care cannot be bestowed upon the management of fresh or recent wounds to carry out the essential points of treatment to which attention has been so often drawn.

Consecutive Hæmorrhage.—This form of bleeding is that which takes place within twenty-four or forty-eight hours after the reception of the wound. When it occurs, it is of little consequence whether it is to be attributed to some imperfection of the means employed to check the primary hæmorrhage, or to the reopening, during the period of reaction, of a vessel which had been temporarily sealed by a clot at an earlier period of the case. It has to be dealt with, and with decision. When trifling in amount, it need not be regarded with anxiety, and more particularly when there is room for the blood to escape through the drainage-opening or tube, although even then it will be well for the surgeon to see that the wounded part is elevated and watched. If the bleeding vessel be a small or cutaneous one, these means will probably be enough; if, however, the bleeding is persistent, or if the parts about the wound swell and become tense and painful, and more particularly if pallor of the skin, feebleness of pulse, restlessness, and other signs of collapse furnish definite signs and symptoms of loss of blood, the wound must be opened, the clots turned out, the source of the bleeding looked for, and the vessel secured.

At times the mere opening and exposure of the wound will arrest bleeding, and under these circumstances, when the bleeding vessel cannot be found, it is well to have the

parts exposed for a few hours, and either to bring them together again when they have glazed and when most chances of bleeding have passed, or to leave them open to granulate. The wound should, however, be left open under only exceptional circumstances—when the hope of quick union is very small or when such union is undesirable.

When the bleeding vessel has been found, it is to be secured, and the wound treated as a fresh one and reclosed. At times, where oozing of blood is persistent, moderate pressure upon a wound does much good, and this may be well applied by means of an ordinary or a rubber bandage over a sponge or elastic antiseptic pad. Care must be taken, however, that the pressure be not too great.

Secondary Hæmorrhage.—This is the form of bleeding which occurs after the lapse of two or three days. It may occasionally be due to the existence of the hæmorrhage diathesis, but is more commonly owing to some ulceration of the vessel in the line of ligation before the vessel itself has been closed by natural processes, or to some sloughing of the end of the divided artery or vein, with or without sloughing of the wound itself; to some imperfection in the means employed for the arrest of the primary bleeding, or to the accidental separation of a ligature. When it takes place in a wound that appears to be healthy, and in which the reparative process seems to have progressed in a satisfactory manner, the hæmorrhage will probably be found to have come from a vessel that has been imperfectly secured or the end of which has been irreparably injured, and under these circumstances, if the bleeding be profuse and evidently from a large artery, the wound must be reopened and the bleeding orifice sought for and dealt with as in the original wound. But if, on the other hand, the bleeding is not severe and the probabilities of the case are that the vessel is not large, the injured limb should be raised and moderate pressure applied; for by such means there will be a good prospect of a successful issue being obtained. Should a recurrence of the bleeding, however, occur, and the effects of loss of blood show themselves, the wound must be reopened and the bleeding vessel secured. When the bleeding comes from a vessel which, with the surrounding tissues, has sloughed, it is a better practice to secure the vessel at a distance from the wound. When, however, the bleeding takes place in a case in which an artery has been *tied in its continuity*, the surgeon should delay reopening the wound, unless the evidence be strong that the blood comes from the supplying or afferent trunk, since experience has fairly taught us that in a large number of these cases the blood comes from the lower or distal orifice of the ligatured vessel, and that under such circumstances it may be readily arrested by the elevation of the limb and well-applied pressure. In all cases, however, when the bleeding is recurrent and persistent, the wounded vessel should be looked for and secured either at the seat of bleeding or, when this is either difficult or dangerous, at a higher point.

Pain.—There is no effect of wound or operation which varies more in degree than pain. In one case the subject of a simple wound will suffer much pain, while another individual with a severe wound will experience but little. Persons vary greatly in regard to nervous susceptibility; nevertheless, pain is under all circumstances a serious symptom and a grave evil, for it tends to depress the moral and physical forces of the strongest patient, and to exhaust even to death the feeble powers of the fragile. I am convinced that I have known pain to kill.

In all wounds, therefore, operative or otherwise, it is important that pain should be guarded against; and for this object surgeons can do much by care and forethought. The wounded parts should be rendered immobile, well protected, and so placed as to give rise to the least inconvenience or distress. The dressings, likewise, should be so regulated as to give comfort. In most wounds, and after most operations, some pain will be necessarily experienced, but as a general rule it will subside in the course of one or two hours. To relieve this symptom, however, it is well to give opium in some of its forms; and for this purpose, after an operation in which an anæsthetic has been used, it is an excellent plan to introduce into the rectum, before the patient becomes conscious, a suppository containing from one-third to one-half a grain of morphia. The anodyne begins to exercise its calming influence before the effects of the anæsthetic have quite passed off, and in some instances the action of the two drugs appears to be continuous. In other cases the subcutaneous injection of a *small* dose of morphia may be resorted to, or a full dose of the same drug may be given by the mouth. Under all circumstances, the early pain after a wound or operation is to be subdued.

Causes of Persistent Pain.—When the pain is persistent and continuous after the healing process has progressed or perfected itself, some nerve complication may be suspected. It may be that some nerve branch has been included in the ligature placed

around a vessel, or some nerve trunk may be so involved in the cicatrix of the wound or so bound to bone or fascia as to be kept continually irritated or even inflamed, or it may be that no definite cause for the pain can be made out, when the case, for want of better knowledge, is regarded as neuralgic.

When the cause of the pain can be determined, this should be removed; and when no cause can be ascertained, the surgeon may be justified in cutting down on the affected nerve and stretching it or in subcutaneously dividing it, as suggested by Hancock. As constitutional remedies narcotics may be given, with tonics such as quinine, iron, or arsenic.

Muscular Spasms.—The muscular spasms or twitchings which follow wounds, and more particularly amputations, can generally be prevented by the careful application of splints and well-directed pressure. They should be put down as preventable sources of distress, and should be guarded against in the early dressing of the case. Well-adjusted pressure, with rest of the injured part, is the one thing to be relied upon to prevent and relieve this symptom, and it rarely fails. The judicious use of narcotics should, at the same time, not be neglected.

Defects in the Healing Process and Diseases of Granulation.

Defects in the healing process may show themselves in either "*deficiency*" or "*excess*" of action, or in some morbid state of the granulating wound.

Deficiency of Action.—In the old and in the very feeble, whether from disease or otherwise, deficiency in the reparative power is to be expected, since for repair a balance of reserve force at the bank of health is requisite, and where such a balance is absent the extra force required for healing will be deficient. Wounds in subjects such as these, consequently, simply fail to heal, or heal slowly or in the worst way, their failure resulting from a want of either the right quantity or the right kind of nutritive supply and nerve force. In wounds in which quick union is aimed at the parts which have been brought together will simply not unite, and they will remain together only as long as they are held in position by the mechanical means employed for the purpose.

In the young and in the middle-aged the same failure in repair is likewise at times seen in cases of hare-lip or other plastic operations in which quick union is needed for success; the parts do not unite by primary adhesion, but gape and granulate, and the operations consequently fail. In such patients, also, fractures sometimes fail to unite as they ought, or unite but slowly: and this may be the case even when no definite cause for the deficiency in the reparative process can be detected. In all such instances, however, there is want of power from some general or local cause, which must be detected before treatment can be rationally or successfully applied.

In wounds in which union by primary adhesion is looked for, the failure may be partial or complete. When it is *complete*, the wound must be regarded and treated as an open one: and under these circumstances the sutures should be removed and the surface cleansed and kept clean, and then stimulated by some dressing, such as carbolized oil 1 to 40, terebene and oil 1 to 4, boracic acid lotion 1 to 10, or boracic acid ointment 1 to 5; or chloral or chlorate of potassium lotion 10 grains to the ounce. At the same time, the wounded part should be placed in the most comfortable position, and in that which will be most favorable for the process of repair. The constitutional treatment should likewise be of a tonic and stimulating character, with good, abundant, though simple, food, and with wine or spirits in sufficient quantity to aid digestion and to enable the feeble heart to send its contents to the nerve centres, to give them force, and to the digestive apparatus, to enable it to utilize the food and pass on waste matter. The patient at the same time should be placed in the best hygienic surroundings.

Treatment when Partial Union has taken Place.—When, however, the failure in primary adhesion is not complete, but *partial*, and when there is the smallest foundation for the hope that by keeping the parts together the required repair may yet be secured, the sutures should be left in position, the wound cleansed with some medicated antiseptic lotion, and, if necessary, either another suture introduced or some other means employed to bring and to keep the parts well together. Even should failure follow the attempt to gain primary adhesion, success may crown an effort made to secure secondary adhesion of the granulating surfaces or union by the third intention.

Where the cause of non-union is local and only temporary, these measures will often succeed, and will turn what seemed to be a failure into a satisfactory result. In hare-lip, and in most plastic operations, a rigid adherence to this surgery of hope and discretion is to be highly commended.

Defects in the Healing Process from Excess of Action or Inflammation.—When excess of action takes place in a wound in which repair by primary adhesion is looked for, disappointment, in all probability, will be the result; for whenever there is in a wounded part more vascular action than is required for the reparative process to perfect its work, repair is first interfered with, then stopped, and finally the wound, when not held together mechanically by sutures, strapping, or bandages, gapes or opens.

When excess of action or inflammation attacks an *open* wound that is granulating and cicatrizing, repair likewise ceases; the granulations, instead of presenting a healthy, florid appearance and secreting a bland, creamy pus, become œdematous or glazed, what has been a granulating becomes an ulcerating surface, and the secretion from the wound changes from pus to a thin serous discharge, with more or less *débris* of tissue. The thin red marginal line, with its cicatrizing edge extending on to the granulating surface, presents a more or less extended area of vascular congestion, this being, when the action is *sthenic*, red to an extreme degree, but when *asthenic* tending toward blue, the redness shading off in intensity toward the blue lividity of congestion. The surrounding parts, moreover, will under these circumstances be tense from inflammatory effusion, hot and painful when the inflammation is acute; but when this is of a lower type, they will be œdematous, boggy, less painful because less tense and less hot. When the local inflammation is sthenic, the constitutional disturbance will coincide with it in type, and the symptoms will be those of inflammatory fever; when the local action is of a low and asthenic form, the constitutional symptoms will partake of the same nature, and will approach those of low fever.

It is to be known, and also remembered, that the acute or *sthenic* form of inflammation, as a rule, attacks a wound when newly made and is generally excited by some local cause—possibly from the original injury, more probably from some imperfection in its primary dressing, and most probably from the retention of some irritating fluid in the depths of the wound from want of proper drainage. This is more likely to occur in wounds of certain parts or tissues—as in wounds of joints, wounds of large cavities, and deep punctured wounds—than in lesions of another character.

The *asthenic* form of inflammation, as a rule, attacks wounds at a more advanced period—when the first effort at natural repair has been made and has more or less succeeded, and when it might seem as if the effort to repair the part and the power to effect that repair were not commensurate. At any rate, in the treatment of these two forms of inflammation when attacking wounds, it will be safe to assume that such is the fact; for while in the acute or sthenic variety a local cause for its production should be looked for in order that it may be remedied, in the asthenic or later kind the recognition of the fact that the inflammation is due to a deficiency of general power is all-important.

Treatment of Inflammation Affecting Wounds.—In the *sthenic* form of inflammation the local and general action is to be subdued by giving free vent to pent-up fluids by the local application of ice or of some other means of applying cold, by the local abstraction of blood, and by free purgation. In the latter purpose there is nothing better, after a good purge, than repeated small doses of a saline cathartic, such as Epsom salts. When suppuration takes place, it must be suitably dealt with.

In the *asthenic* form general tonics with stimulants and nutritious food are essential; locally, absolute cleanliness, the free exposure of the wound for purposes of drainage, and the constant use of such stimulating antiseptic applications as the nature of the case may suggest, with, possibly, warm medicated irrigation, should be employed. Cold, locally applied, is rarely beneficial.

Diseases of Granulations.

When an open wound heals or a cavity fills up with reparative material, it does so by a process of granulation; and when this process takes place in a healthy subject and under favorable conditions, the granulations present certain appearances known as healthy. When, however, the same kind of repair is being effected in a feeble or diseased subject or under circumstances which are not favorable for its progress, the granulations present different appearances, these being, as it were, *pathological*, in contradistinction to those which are seen when the ordinary *physiological* process of repair is being carried out—a process which is very closely allied to, if not identical with, that of development and growth.

In a *healthy* surface the granulations appear as small conical masses of granulation

tissue covered with a thin layer of pus cells. They are of a bright florid-red color, and are fringed at their skin border with the well-known thin blue line which is so indicative of healthy "cicatrization." During the whole of the healing process this appearance is maintained, the only visible change being the gradual diminution of the granulating surface by the steady approach of the "thin blue line" toward the centre. Healthy wounds undergo contraction at the rate of from one to one and a half inches a week. In the different appearances of these granulations under diverse circumstances, the educated eye of the surgeon can rapidly read not only every important change in the bodily condition of the patient, but almost every variation, from day to day, in the patient's health. I have been long in the habit of describing a granulating surface as a kind of weather-glass or barometer of health in which the surgeon can read in the changed appearance of the granulations themselves, and of the "thin blue line" of cicatrization, the slightest deviations from the healthy type; for while it is true that as long as a granulating surface is healing kindly the inference is correct that the subject of the "sore" is healthy, it is equally certain, when the surface has deviated from the healthy path, that there is something wrong either in the patient, in the part itself, or in its treatment. Thus, in a patient who is anæmic, the granulations will be pale and bloodless; and when this condition has been of long standing, they will lose their small conical form and appear as coarse watery elevations. When there is any interference with the return of the venous blood from the granulating part, from either heart disease, the dependent position of the limb, or the improper use or bad application of bandages or other mechanical appliances, the granulations will appear "congested" to variable degrees, and may even bleed. They may be so full of venous blood as to put on the purple appearance which suggested to the old authors the name of the "juniper ulcer," the granulations looking blue or black as a juniper. When the ulcer bleeds, it is generally called *hæmorrhagic*.

When the reparative power is feeble and granulations form, they will be of a pale, watery, œdematous character, and the discharge from them will not be normal pus, but a seropurulent fluid; the granulations that form are of a weak type, and the sore then constitutes what is wrongly called a "weak" ulcer.

When from some constitutional or local cause the reparative process is more deficient in force, the surface of the sore will either present a few ill-formed and feeble granulating spots or appear smooth and apparently wanting in granulations altogether, and look to the eye not unlike the tense mucous surface of the pharynx. In other cases, in which this deficiency in force is greater, the sore may present a greenish, dirty-colored surface, discharging an acrid or putrid substance which is clearly blood and serum mixed with the decomposing elements of dead tissue, the ill-formed granulation or granulative tissue in these cases dying superficially as soon as formed, for want of power to live and develop.

In still more extreme cases of deficiency of power, what may have been a reparative process not only ceases to be so, but becomes retrograde; what had been a *constructive* changes into a *destructive* force, and the tissues that should have been repaired break down and undergo molecular disintegration; the sore, instead of healing, becomes an ulcer, the new tissue dying from want of vitality.

On the other hand, *excess of action* may at times affect a healing sore; and when it does so, it affects the granulating process as much as it has been shown to do a wound in which quick union or primary adhesion is sought for. In the stage of irritation, or that in which the granulation tissue is simply overstimulated, overaction shows itself in an excess of secretion from the granulating surface, in the shape of pus, and probably in some increase in the size and redness of the granulations themselves; and when this is other than a passing condition from some temporary cause, it will soon become one of inflammation.

When inflammation attacks a granulating sore, changes will occur similar to those which have been described as taking place when it affects a healing wound. Physiologically there will be an arrest of the healing process, an arrest of secretion from the granulations, and, if the action be lasting, a change from what had been a healing process to one of ulceration. The ulceration will be more or less rapid and associated with all the local and general phenomena of inflammation, such as redness and heat of the margins of the sore and the adjoining tissues, with pain and swelling. The degree and character of the inflammation regulate these appearances; an inflamed sore or granulating surface presents as many different aspects as there are degrees or kinds of inflammation, for inflammation must be regarded as an accidental complication of the sore, and it may attack it in any stage of its progress or in any condition.

At times the granulating force may be in excess and so act as to prevent repair. The

granulations sprout above and beyond the margins in which the "cutifying" action is carried out, and appear either as elevated luxuriant growths in the centre of a sore or at the orifice of a sinus, or as overhanging florid granulations at the cicatrizing border. In these cases there is simply an excess of force, and this excess exhibits itself in fungous granulations.

Again, a granulating wound, when of long standing, may show on its surface or in its surroundings evidence of the existence of many constitutional or specific conditions—that is to say, a chronic sore in a patient who has a syphilitic taint may present features by which the presence of the syphilitic poison can be recognized, and a chronic sore in a scrofulous subject will manifest conditions which, if not special, as in the syphilitic, will be clear enough to indicate sufficient feebleness and torpidity of action to suggest the existence of some general dyscrasia.

On Inflammation.

When a visible part is inflamed, there are four notable phenomena to be observed—namely, REDNESS, HEAT, PAIN, and SWELLING—and these four symptoms are all associated with, if they are not directly due to, an *active* congestion of the capillaries, with more or less blood stasis of the inflamed tissue. This hyperæmia, or congestion, is, moreover, accompanied with cell changes in the seat of inflammation. There is likewise an arrest or annihilation of the functions of the part, and in the case of a wound an arrest of its repair, and later on destructive changes. Redness and heat are the most typical of these four symptoms, and heat is the more characteristic, increase of heat being, without doubt, the most important clinical local symptom of inflammation.

The "*redness*" may be localized or diffused, of a bright-red color or of a livid hue, the former tint indicating a healthy or *sthenic*, the latter (evidencing want of power) an *asthenic*, inflammation. It is clearly due to the capillary injection of the part, for in the sthenic form the circulation through the capillaries is more active than it is in the *asthenic*, in which the dusky congested livid color suggests blood stasis.

The "*increase of heat*" is probably due to the *accelerated* flow of *overheated* blood through the hyperæmic tissues, as well as to increased activity in the tissue changes of the inflamed part; but the local heat probably is never greater than that of the blood. John Hunter's sagacious utterance on the subject one hundred years ago—"that a local inflammation cannot raise the temperature of an inflamed part above the source of the circulation"—being declared by Sanderson now to be correct both in fact and theory.

The "*swelling*" or "*hardness*" is to be explained by the nature of the tissue involved and the degree of blood stasis which is attained in the tissues. The serum of the blood, with its coagulable lymph, passively exudes from the gorged capillaries into the connective tissue of the inflamed part in the early stage of inflammation when the stasis is incomplete, and the emigration of the white blood corpuscles or leucocytes or protoplasmic atoms follows when it is more so. Absolute death of the involved tissue takes place when the circulation through the capillaries is entirely stopped, the exudation from the slowly-flowing blood stream of corpuscular liquid being, in the words of Sanderson, "the central phenomenon of inflammation."

"*Pain*" is a symptom which varies much as to its character as well as to its intensity, and depends a great deal upon the amount of tension in the inflamed part. In inflammation of the bone, periosteum, or of any part bound down by an unresisting fibrous tissue, such as the coat of the testis, the sclerotic of the eye, or the socket of a tooth, the pain is intense; in rheumatism in which the fibrous structures of the joints are inflamed it is also marked. Probably it is caused by direct pressure on the extremities of the nerves of the stretched or tense tissue.

We thus have *redness*, *heat*, *swelling*, and *pain* as symptoms of overaction of a part, or what is called *inflammation*, and they one and all appear to be direct consequences of extreme capillary vascularity of the tissue, whether that be the result of a wound or not. The blood stream through an inflamed limb has been demonstrated by experiment to exceed the normal flow in the proportion of something like four to one. These symptoms may manifest themselves in every degree of severity, their extent depending upon the intensity of the inflammatory action and the nature of the tissues that are involved. When a loose tissue is involved, the redness will be much marked and the swelling will probably be rapid, but the pain will certainly be slight, as the tension of the part is rarely severe. When the connective tissue situated beneath a dense fascia is the seat of inflammation, or when bone is involved, the redness may be absent and the swelling com-

paratively slight, since the peculiarities of the part affected prevent their being manifested; but the pain will probably be severe, for the tension of the tissues and the pressure upon the nerves of the part will under such circumstances be necessarily great.

When the inflammation is *acute* or rapid, all these symptoms manifest themselves with great rapidity, and the results of the action are quickly shown; when it is slow or *chronic*, they are less clearly marked.

Associated with these local symptoms of inflammation there will always be some constitutional disturbance, which is known as *inflammatory fever*. This fever may manifest itself in all degrees of severity, its intensity depending much upon the character of the inflammation and its seat. When a local affection is *acute* or of a *sthenic* nature, the constitutional disturbance will be severe; when *chronic*, it will probably be mild; and when *asthenic*, it will be marked by great depression. It may show itself, therefore, only as a slight febrile state, or it may be marked by the severest symptoms.

"Taking, for instance, a case of severe compound fracture, without much hæmorrhage, in a person otherwise sound and strong, as a type of the affection, we find that before twenty-four hours have elapsed from the time of injury his general system begins to be thus affected: He feels hot or alternately very hot and chilly. His skin and lips and mouth are dry. He passes urine in less quantity, but of a higher color, than usual. His pulse is quickened. A sense of general disorder gains upon him. He becomes restless and intolerant of disturbance. Signs of drought increase with him. His urine becomes scantier and more colored. His skin feels hotter to the surgeon's hand, and his pulse, whether full or hard, is quicker and stronger than before. He craves more and more for water. His face has a flushed, anxious look. He is thoroughly uncomfortable, for the most part feeling distressingly hot, but at irregular intervals feeling touches of chilliness—sometimes even of such cold that he shivers with it. His sleep is troubled and unrefreshing, or as night comes on he gets delirious. His tongue, besides being dry, is furred. If his bowels act (which commonly they are inapt to do without laxatives), the excretions are morbidly offensive. Gradually these symptoms give way; in proportion as the injured limb ceases to be tense and passes into suppuration, the skin and mouth become moist again; the excretions lose their concentrated character; the hard pulse softens and the heart's action becomes quiet; the nervous system is no longer restless; the look of trouble passes from the countenance, and the patient can again take solid food."[1]

There can be little doubt that these symptoms are clearly due to an increase in the temperature of the blood, and that their severity is measured by it. This is, indeed, as Simon has so aptly expressed it, "the essential fact of inflammatory fever. It is to this fact that the familiar language of feverishness bears witness—the thirst, the scanty urine, the heat and the shivering, the troubled brain, the excited circulation. As the blood gets hotter and hotter, more and more do these symptoms become developed. As the blood subsequently gets cooler, so, more and more, do they decline."

Average Temperature.—The average temperature of the healthy human body, according to the Wunderlich, is 98.6° F. or 37° C., but the range between 97 and 99, is quite consistent with health. A febrile condition arises from an increase of temperature accompanied by more or less constitutional disturbance.

Excess of Temperature.—It seems from Dr. Montgomery's observations, made for Mr. Simon, that "febrile excesses of bodily temperature range perhaps to ten degrees above the normal heat of the blood; the 'crisis' of a febrile state consists in a rapid and generally continuous reduction, the 'lysis' in a slow and generally discontinuous reduction, of this abnormal temperature." With respect to the causes of this greater heat of blood, it is probable that the fever originates in the tissues themselves and is a disorder of protoplasm, the results of inquiry showing "that either continuously during the intensity of feverishness, or else more abruptly when feverishness begins to subside, there can commonly be traced in the excretions an excess, more or less considerable, of those nitrogenous, sulphurized, and phosphorized products which emanate from textural and humoral waste; that this increased elimination is observed even when ingestion has been reduced to a minimum; and that febrile excretions do, therefore, as a rule, undoubtedly attest an increased devitalization of bodily material." The febrile process is then clearly a disorder of nutrition in which, in man, the exchange of nitrogen exceeds the normal expenditure by nearly three-quarters, and in which there is likewise an excessive discharge of carbonic acid. The discharge of nitrogen is evidently due to the disintegration of tissue, or possibly of blood. This fact explains the rapid waste of body which takes place in fever. The blood coagulates with what is generally described as a "buffy

[1] Simon's art., Holmes's *System of Surgery* (second edition), vol. i. p. 26.

coat," and it seems highly probable that under these circumstances it contains more than its normal complement of fibrin. There is good reason also to believe that this "buffy coat" is due to the fact that the blood corpuscles subside in the liquor sanguinis during coagulation, leaving the upper portion of the clot colorless. What this increase of fibrin in the blood in inflammation means is a question that remains to be decided. Some pathologists believe that the blood is excellent in proportion as it is fibriniferous; that solidifying fibrin is almost incipient tissue; that the fibrinous crust, as drawn in inflammation, is the sign of its being specially adapted to the purpose of additional growth; while Simon, with others, holds "that the blood yields more fibrin, not in proportion as it is ripe and perfect, but rather in proportion to quite opposite conditions; that an increased yield of fibrin portrays, not perfection, but post-perfection, in the blood; that it corresponds, not to the rise, but to the decline, of albuminous material; that the relations are not with repair, but with waste; that its significance is that of something intermediate between life and excretion; that the fibriniferousness of the blood is undiminished—probably even increased—by bleeding; that it is greatly developed during starvation, during violent fatigue, during diseases essentially anæmic; that its increase under these circumstances of exhaustion, weakness, and inanition is to the full as great as its increase during inflammation."

"These latter views seem to be most in accord with truth and with the general chemistry of inflammatory fever. They seem to indicate that the fibriniferousness of the blood in inflammation represents action of devitalization and decay in some albuminous material. Whether this changing material be the inflamed texture gradually dissolving itself into the blood, or be the albumen of the fevered blood itself undergoing accelerated waste, cannot in the present state of knowledge be even approximately stated" (Simon).

The Effects of Inflammation on the Tissues.

More or less complete *stasis of blood* in the inflamed tissue is the first effect of inflammation, as hyperæmia with greater activity in the circulation of the part is the first symptom. With this stasis there is a slowing of the blood stream through the dilated capillaries, with a crowding together of the white corpuscles or leucocytes along their walls, and later on a migration of these same cells from the vessels into the tissues.

Blood Stasis.—When the stasis is more than transitory, the red blood cells themselves may extravasate into the tissues with the leucocytes; and when the stasis is complete, death of the tissue in which the choked capillaries exist ensues, "stasis being the mechanism by which inflammation kills" (Sanderson).

Effusion.—The effusion which takes place into a tissue the seat of inflammation is clearly due to stasis. "It begins from the moment that the damaged vessels are distended with blood and the internal surfaces of the walls pressed upon by their contents" (Sanderson), and it varies with the activity, character, or specific nature of the inflammation. When the inflammation is of a healthy or *sthenic* kind, it tends toward the fibrinous variety, producing plastic infiltration of the part; when of a feeble or *asthenic* form, the serous and corpuscular elements predominate. In the former case the soft tissues appear firm and dense, and in the latter soft and œdematous.

Recovery by Resolution.—In healthy subjects this plastic material may be reabsorbed and the tissue into which it had been infiltrated left perfectly sound, recovery then taking place by what is termed *resolution;* in exceptional instances the plastic material may become organized.

Other Effects of Inflammation.—In unhealthy subjects, or in cases of intense inflammation, in which tissue is destroyed from blood stasis, the infiltrating material, with the inflamed tissue, either undergoes destructive changes and breaks up—when what is known as "*suppuration*" takes place—or the tissue as a whole or in part dies or "*mortifies.*" The act of *suppuration* means the formation of pus and the destruction of the inflamed tissue.

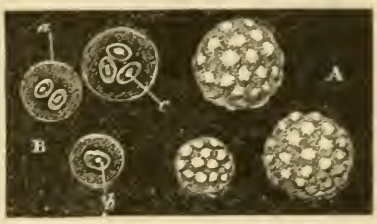
Mortification.—The death of a part from inflammation means its *mortification;* when the action is a spreading one, it is called "*gangrene*" or "*sloughing phagedæna,*" and the dead part thrown off is called a "*slough.*" The death of bone is called "*necrosis,*" and the dead piece of bone a "*sequestrum.*" When a portion of tissue dies, the dead is separated from the living piece by a process known as that of "*ulceration,*" ulceration of a part meaning its molecular death. When ulceration spreads, an ulcer is said to exist; when this undergoes repair, it does so by *granulation.*

"Resolution," "suppuration," "ulceration," and "mortification" are the four events of inflammation.

Pus is the product of inflammation, and it consists of leucocytes, granules, and the *débris* of the inflamed tissue floating in serum. Cohnheim considers the leucocytes to be the sole source of purulent infiltration, and Stricker believes that the formation of pus is synonymous with disintegration of tissue, the cells of the inflamed part by the act of inflammation being made to return to their embryonic state, and the amœboid protoplasmic material of which they are composed forming, by subdivision, amœboid cells. The inflamed tissues by these changes are transformed into pus corpuscles.

Pus, when seen upon the surface of a granulating wound, varies with the condition of the wound. When the granulating tissue is healthy, the pus will be healthy—that is, it will appear as a yellowish-white cream-like fluid with a sickly smell and an alkaline reaction. Under the microscope the cells will appear like leucocytes. When the wound is inflamed, leucocytes will be present, but under changed conditions—that is, they will appear as nucleated cells, with two to five nuclei (Fig. 10) mixed with granules and the *débris* of the inflamed tissue; under other circumstances the pus may be mixed with blood. In indolent sores, where the granulating power is at a minimum, the pus cells will be few and the serum in which they float abundant.

Fig. 10.



A. Pus corpuscles (magnified 350 diameters). B. Same made transparent with acetic acid. *a*. Cell-wall. *b*. Nucleus. *c*. Nucleolus. (*After Lebert.*)

Living pus is composed of leucocytes and serum—liquor puris; dead pus is made up of nucleated cells containing from two to five nuclei, granules, and serum. The leucocytes show their amœboid movements in the living, but not in the dead, pus. All pus is soluble in alkalies and has an alkaline reaction. Acetic action dissolves the nucleus of a leucocyte, but renders clearer the nuclei of a dead pus cell. The pus of a chronic abscess is not only dead, but undergoing degeneration: its cells are large and full of fat cells. The fluid in which the pus cells float likewise contains fat and granules in abundance.

Accidental elements may be found mixed with pus under exceptional conditions, such as cholesterine plates and bone and other tissue elements; when vibrios and micrococci exists, the pus is undergoing chemical and fermentative changes.

Varieties of Pus.—Pus, when thick and creamy, is known as "healthy," or *laudable*, pus; when thin and watery and containing ill-formed pus-cells, it is called "puriform fluid," this condition being generally indicative of want of power; when it is blood-stained, it is called "sanious;" when thin and acrid, "ichorous;" and when it contains flakes of curdy lymph, "curdy." Pus from the interior of a bone is oily, containing, as Brandsby Cooper showed, granular phosphate of lime. Pus from the brain is often green, from the liver brown, the *débris* of broken-down tissue in different proportions and of different kinds giving these appearances.

ABSCESS.

A *circumscribed* collection of pus in any tissue is called an "*abscess*." When pus is not circumscribed, but diffused in the connective tissue beneath the skin, between muscles, or along tendons, and *infiltrates* a part, *diffused suppuration* is said to exist, this latter condition always indicating want of power.

Varieties.—An abscess is always the result of an inflammatory process. When it forms rapidly and is associated with severe local as well as constitutional symptoms, it is known as an "acute abscess;" when it is of slow formation and the symptoms attending its progress are mild, it is called a "chronic or cold abscess;" but there are many intermediate forms. In an "acute" abscess the pus and broken-down tissue are circumscribed by the organization of the coagulable lymph and the parts around are infiltrated with serum, as indicated by pitting on pressure. In a "chronic" abscess the walls are thick, from the organization of the inflammatory products, whereby nature checks the extension of the disease and forms what surgeons of old called the "pyogenic" membrane, which is well exemplified in chronic abscess in bone.

An Acute Abscess is invariably preceded by the constitutional symptoms of inflammatory fever, and is accompanied by the usual local phenomena of inflammation, such as pain, redness, heat, and swelling. As the abscess forms the local symptoms become intensified, and perhaps concentrated; the pain alters in character, becoming at first dull and heavy, and then throbbing; the fever symptoms also sub-

side, or rather intermit, and a shivering fit or rigor more or less well marked, followed by heat, and possibly sweating, takes its place. The swelling, moreover, which was previously diffused, becomes more localized; a soft, and possibly tender, spot, with a surrounding area of œdema, shows itself, and the parts covering it begin to thin. With the fingers of one hand steadily kept flat upon the swelling, and those of the other made to press upon it in another part, the walls of the abscess will be made to rise against the fixed fingers and a sense of "fluctuation" be given, this feeling of fluctuation indicating the presence of fluid, and, in this particular case, of pus. Under these circumstances the "pointing" of the abscess will soon take place; meaning by this, the thinning of the part covering in the abscess in the direction of least resistance, the subsequent bursting or sloughing of the skin, and the discharge of the abscess cavity's contents. When the pus has been evacuated, the walls of the abscess, by their natural elasticity, fall together or collapse, the external wound closes, and the abscess either heals or contracts into a *sinus* or narrow canal, sometimes called a *fistula*. When the pus is *deep-seated*, or bound down by fascia or periosteum, what is called "*burrowing*" takes place; the matter makes its way between the soft parts, where the least resistance is met with, and opens either into a mucous passage, serous cavity, or joint. Abscesses beneath the periosteum constantly open into joints; those beneath the abdominal muscles or within the abdomen, into the intestinal canal; and others in the extremities may burrow beneath the muscles and make their way to the surface a long way from the original seat of the disease. In disease of the dorsal vertebræ an abscess may burrow beneath the abdominal fascia, extend behind the sheath of the psoas muscle, Poupart's ligament, and deep fascia of the thigh, and open on the inside or outside of the thigh; whilst in other cases it may pass into the pelvis and out again at the sciatic notch, and appear in the buttock as a "gluteal abscess." In disease of the lumbar vertebræ an abscess may also form, burrow between the abdominal muscles, and appear in the front of the abdomen above Poupart's ligament. An abscess beneath the scalp may undermine the whole scalp tissue; one behind the fascia and muscles of the pharynx may spread so as to cause a large post-pharyngeal tumor and cause death by suffocation; while deep-seated abscesses of the neck may burrow into the thorax, and thus produce fatal mischief. These instances serve to show how pus, when confined beneath a strong membrane, will burrow along the cellular tissue of a part to find some outlet, and how necessary it is for the surgeon to be aware of the fact in order that he may stop the process or trace the cause of the disease to its source.

The "*diagnosis*" of an acute abscess ought not to be difficult; but when the abscess is chronic, the same cannot be said. Every hospital surgeon can record errors of diagnosis in which chronic deep-seated abscesses have been mistaken for cancerous or sarcomatous growths, and even for aneurism, and in which breasts have been removed for cancer which were the subjects of chronic abscesses. The knowledge of these past errors, it is hoped, will do much toward guarding against their future perpetration; but the best security is caution and a diagnosis of the case by the process of reasoning by exclusion as laid down on pages 17, 18.

Chronic abscesses are of remarkably slow formation and give rise to very little constitutional disturbance or local symptoms other than swelling; indeed, except mechanically, they seem to be of little annoyance unless they are secondary to some organic disease. Even then it is astonishing to what a size a chronic abscess will sometimes attain before it is discovered or complained of. In spinal cases this is often verified. In children, also, large abscesses form in the same quiet way. They are, however, never met with in the robust and strong. Abscesses connected with enlarged glands are peculiarly passive in their progress, and cause pain only when they begin to make their way through the skin. Those, again, which occur in chronic joint disease when the disease seems to be undergoing recovery show themselves in the same quiet way. Sir J. Paget[1] has described these as "residual abscesses." They seem to be a simple breaking down of old inflammatory products poured out in the cellular tissue during the more active period of the disease, and which had failed to be reabsorbed or to become organized, much in the same way as a scar may break down after a fever.

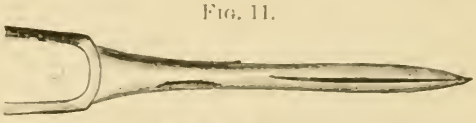
Absorption of Pus.—Pus may be absorbed, the serous fluid in which the cells float being taken up and the cells left to wither, these subsequently forming a pultaceous, and at a later date a cretaceous, mass. Clinically, however, pus may disappear altogether and leave no external evidence of its former existence. The fact is now clearly recognized by surgeons, and the absorption of pus is constantly seen in the eye in hypopyon,

[1] *Clinical Lect.*, second edition, 1879.

as well as in the disappearance of periosteal enlargements and chronic subcutaneous abscesses. This result, however, can only be expected in chronic cases which are not connected with deep-seated organic mischief.

Treatment.—In all cases of acute suppuration the abscess should be opened as soon as it has formed, and in many instances of acute local inflammation the inflammatory fluids should be let out as soon as they have been effused, with the view of checking the inflammatory action and of guarding against the evil effects of "tension" upon the involved tissues. In acute inflammation about the theca of tendons of the hand and foot or of the periosteum this practice should be binding, since an early incision in such cases, by relieving tension, often saves tissue and cuts short disease. The abscess should be opened, also, where it is pointing, and the inflamed part cut into where it is most tense and can be well drained; and this proceeding is best effected with a straight narrow bistoury, such as the pocket-case finger-knife, unless the abscess be small, when a double-edged knife, such as that illustrated in Fig. 11, should be employed. The incision in both cases should be made by means of a vertical puncture into the abscess cavity, followed by a free cut outward, the opening being large enough to allow a ready escape of all pent-up fluid and the subsequent irrigation of the abscess cavity with some iodine or other antiseptic lotion. A piece of lint soaked in terebene or carbolic oil, or a drainage-tube, should then be introduced into the abscess cavity to ensure the escape of any effused fluids that may subsequently be poured out, and the parts in which the abscess exists should be made immobile by splints and bandages. By such treatment the abscess cavity may be expected naturally to contract, its walls to unite, and recovery to take place.

Fig. 11.



Double-edged Abscess Knife with Groove in Centre (full-sized).

During the formation of an abscess, fomentation, poultices, and warm-water dressings give comfort and may be used. They are only admissible, however, when suppuration and external discharge may be expected. When absorption is probable, as in certain residual or chronic abscesses, such means should not be employed, but rather absolute rest of the affected part and an absence of all irritating applications, tonic treatment and regimen being the chief general means upon which reliance can be placed.

Use of Aspirator.—To help this desirable result, it is a good practice to draw off the pus from a chronic abscess with the aspirator of Dieulafoy. I have done this on many occasions with a good result, and no re-collection has taken place, but as often as not the fluid reaccumulated and a free incision was subsequently necessary. Whenever an abscess is opened, the incision should be free enough to admit of a ready outlet of its contents and to prevent any reaccumulation.

Treatment of Deep Abscess.—Wherever burrowing suppuration in a part can be detected, the sooner an external outlet is made the better, whether that burrowing be beneath the scalp, behind the pharynx, among the deep cervical tissues, in the thecæ of tendons, between the layers of muscles of an extremity, or beneath the periosteum; and this is more especially requisite when the suppuration occurs about joints or beneath the deep fascia, and particularly the fasciæ of the perinæum and anus.

Superficial abscesses ought always to be opened. On the neck and face the line of incision should be made to correspond with the course of the superficial skin muscles or the lines or folds of the part, the deformity resulting from the cicatrix being thereby greatly diminished; but in other cases the incision must be in the best direction for emptying the cavity. In all abscesses the puncture should be made where the abscess is "pointing" or the integument is thinnest, and where this indication is absent at the most dependent part of the abscess. The operator should always avoid dividing superficial veins and nerves, the position of the former being made out by intercepting the flow of blood through them by the pressure of the finger. Deep vessels and nerves should be carefully avoided, their anatomical position being always remembered. When abscesses have to be opened in the neighborhood of these important structures, the incision should be made parallel to them.

Mode of Opening Abscesses.—In opening an abscess a plunge ought not to be made. The operator should mark the point of intended puncture with his eye, then, introducing his instrument with decision through the soft parts into the cavity, make the incision of the required length by cutting outward as soon as pus oozes upward by the sides of the instrument. To do this sleepily is to give unnecessary pain, whereas to do

it with a stab or plunge only causes unnecessary alarm. It should be done, as ought every other act of surgery, with confidence and decision, boldness and rapidity of action being governed by caution and made subservient to safety.

To open an abscess that is pointing (or which has a cavity to be felt) by dissecting down upon it is a *bad* practice, although in deep-seated abscesses which are covered by parts which it would be dangerous to wound, where surgical interference is called for, such a method may be the best, extreme caution being requisite under circumstances of extreme danger. In such cases the surgeon should follow Mr. Hilton's method of opening deep-seated abscesses, which has been practised at Guy's for many years.

In deep-seated abscesses in the axilla, says Hilton (*Lectures on Rest*, 1863), "I cut with a lancet through the skin and cellular tissue of the axilla, about half or three-quarters of an inch behind the axillary edge of the great pectoral muscle. At this point we can meet with no blood vessels. Then I push a grooved probe or grooved director upward into the swelling in the axilla; and if you watch the groove, a little opaque serum or pus will show itself. Take a blunt (not a sharp) instrument, such as a pair of dressing-forceps, and run the closed blades along the groove in the probe or director into the swelling. Now, opening the handles, you at the same time open the blades, situated within the abscess, and so tear open the abscess. Lastly, by keeping open the blades of the forceps during the withdrawal of the instrument, you leave a lacerated tract or canal communicating with the collection of pus, which will not readily unite and will permit the easy exit of matter." In this way deep cervical and post-pharyngeal abscesses, deep abscesses of the thigh, leg, and fore-arm, may be fearlessly opened.

After-Treatment.—When an abscess has been opened, it should be left to discharge by itself. Any squeezing or pressing upon the walls of the abscess is unnecessary and injurious. In some a piece of oiled lint should be introduced between the edges of the wound to prevent their closure, more particularly when the deep fascia has been opened; whilst in others of large size the introduction of a drainage-tube made of a piece of india-rubber tubing perforated at intervals may be required; in all, provision for drainage should be made.

Tonics and good feeding are always essential elements in the treatment, sedatives being given only when required.

When a *chronic abscess* requires opening—a question which in every case should be well considered—a free incision should be made into its cavity, its contents evacuated, and the cavity well washed with some antiseptic lotion. For this latter purpose a mixture of one or two drachms of the tincture of iodine to each pint of tepid water is the best; a drainage-tube should then be introduced, care being taken that if air enters its exit also can be guaranteed. The abscess should be washed out daily.

When the Listerian method of dressing wounds is employed, the abscess cavity must be opened under the spray, drained with proper-sized drainage-tubes, and covered with the gauze and protective. An excellent plan likewise consists in making a free opening into the abscess, previously covered with a piece of lint soaked in carbolic oil (one part of acid to twenty of olive oil), beneath which the pus flows away; in this manner no air is admitted. In the subsequent dressings care must be taken to keep the opening surrounded with the vapor of the acid, and the lint should be removed only to be replaced by a freshly-steeped piece. No pressure should be made upon the walls of the abscess for the purpose of emptying its cavity without the opening being covered with carbolic oil. I have, however, used, in several cases, olive oil alone with equally good results.

Suppurating ovarian and hydatid cysts may be treated as large abscesses and with considerable success. Empyemata or abscesses in the chest can also be dealt with on the same principle, by a free opening into the thorax and a free outlet for the pus. In these cases the drainage-tube is of great value, care being necessary to drop one end of it well down to the bottom of the cavity.

The drainage-tube was suggested by M. Chassaignac, and is simply a small india-rubber tube perforated every half inch or so with holes to allow of the free escape of the pus. When large cavities are opened, they should be washed out at intervals with an iodine lotion or other antiseptic fluid, so that nothing like decomposition, as indicated by fœtor, may be allowed. With this precaution, large suppurating cavities can be dealt with successfully.

Hæmorrhage into Abscess Cavities.—When veins and large arteries are opened by ulceration into abscesses—an accident of occasional occurrence—they should be treated on the principle laid down in the chapter on hæmorrhage; *i. e.*, if the bleeding

vessel be large, it should be secured, when possible, at the point at which it has given way, either by ligature or torsion; and if small, the hæmorrhage can easily be arrested by pressure.

Abscesses Associated with Enlarged Glands.—Chronic abscesses associated with glandular enlargement need not be opened under some circumstances, because with constitutional treatment they often disappear; yet they should be so treated as soon as it is clear that they will, if let alone, open by natural processes, in order to save the ugly cicatrix that takes place under these circumstances from ulceration of the skin. The surgeon should make a small puncture in the best line to allow of the exit of the pus and to prevent disfigurement. Gentle pressure with cotton-wool over the part afterward often hastens the recovery. In subjects of the hæmorrhagic diathesis an abscess may be opened by the cautery or canula.

Arrest of Acute Inflammation by the Obstruction of the Main Artery of the Part.

To arrest acute inflammation in a limb, the deligation of the main artery of the limb or the arrest of the circulation through it by pressure upon the artery has been adopted. Dr. Campbell of New Orleans speaks highly of the practice, and even affirms that no portion of an extremity should be amputated for destructive inflammation without this experiment being attempted. On the suggestion of the late Mr. Maunder of the London Hospital, Mr. Little in 1867 applied a ligature to the femoral artery for acute suppuration of the knee with a success sufficient to prove the value of the practice. Mr. Maunder himself afterward had a similar successful result ("Lettsom. Lect.," *Lancet*, 1875). The late Mr. Moore of the Middlesex Hospital also acupressed the brachial artery with a good result. Previous to these cases, however, as early as 1813, Dr. Onderdonk of America ligatured the femoral in a case of wound of the knee-joint to check acute inflammation, and others since his time have followed his practice. It is a method of treatment certainly worthy of attention, inasmuch as to cut off the supply of blood to an inflamed part when too much is passing to it is sound in theory, and to do the same to starve out the disease is equally scientific. In elephantiasis Arabum the practice does not seem to be without its good effect, and in acute disease it is certainly admissible.

I well remember as a student observing, under the care of the late Mr. Bransby Cooper, a serious case of compound fracture of the leg complicated with a severe laceration of the thigh and division of the femoral artery of the same side. He was in doubt as to the practice he ought to follow, not knowing whether with the divided femoral the supply of blood would be sufficient to repair the compound fracture. The success of the case, however, proved that the fear was groundless, for repair went on uninterruptedly, and a good limb was the result. The patient was a man of middle age. In 1873 I also treated with uninterrupted success a case of compound fracture of the humerus into the elbow-joint in a man where the brachial artery was obstructed, in which recovery with a movable joint was accomplished.

With respect to the treatment of inflammation by the *digital* compression of the main arterial trunks leading to the injured or diseased parts, it must be recorded that in 1861 Dr. T. Vanzetti of Padua wrote a paper on the subject, which Mr. S. Gamgee has translated in his work *On Fractures* (1871). He was led to apply this treatment to cases of inflammatory disease from its success in the treatment of aneurisms. He asserts that compression will cure every incipient inflammation, and check it even when advanced: and he adduces cases of phlegmonous erysipelas and acute arthritis of the hand successfully treated by such a process. He adds, however, that "in the treatment of aneurisms, as of inflammations, compression can never become a normal method until it be always and exclusively effected with the finger."

SINUS AND FISTULA.

A Fistula is an unnatural communication between a normal cavity or canal and the outside of the body or with a second cavity or canal.

A Sinus is a narrow and often tortuous suppurating tract with only one orifice.

Amongst the *fistulæ* there are the vesico-vaginal and the recto-vaginal fistulæ in women; the recto-vesical in men; gastric and biliary fistulæ, fæcal and anal fistulæ, salivary fistula, and urinary fistula; there are also the congenital, bronchial, or umbilical fistulæ. The acquired fistulæ are either due primarily to some suppurative or ulcerative

process or to mechanical violence, operative or otherwise, and subsequently to a want of repair. When passages are close together, the fistula in some cases may be short and direct, whilst in others it will be narrow or tortuous; the orifice of the fistula may vary much in size. When the cavity or canal is deeply placed or the inner opening deeply situated, the fistula may be a long narrow tract. When the fistula is of *recent* origin and lined with granulations discharging pus, the walls will be soft, and will readily bleed on manipulation. When *old*, they will be smooth and hard, or "callous," and non-sensitive, and will secrete a thin, watery, non-purulent fluid. This fluid is, moreover, mixed with the contents of the cavity or tract with which the fistula communicates, the discharge tending to keep the fistula open.

The *external* opening of a fistula or sinus presents very different appearances. It may appear as a direct or as a valvular opening, or may be depressed or raised. When leading down to a foreign body or to bone, the external orifice will be surrounded by weak granulations. Sometimes it may scab over for a time, and then reopen by the force of the retained fluid. The *internal* opening of a fistula mostly appears as a defined orifice.

Causes of Sinus.—Abscess is the most common cause of *sinuses* or incomplete fistulæ, the external communication failing to close from defect in the healing power of the part, from some interference with the reparative process, from the want of a sufficiently free vent for the discharge of pus, from muscular action which forbids that amount of rest which is required for its repair, or, lastly, from the presence of some foreign body introduced from without, or from dead bone or cretaceous inflammatory product from within.

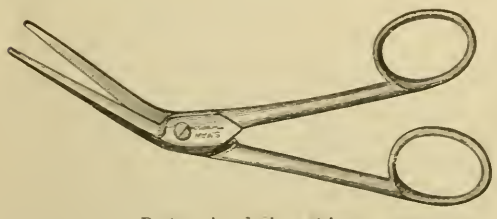
The TREATMENT of the different forms of fistulæ is given in the chapters devoted to the special organs that are involved. In a general way, however, it may be asserted that so long as the cause of the fistula exists repair cannot go on; so that in "*urinary fistula*," when stricture is the cause, the stricture must be treated before the fistula. In "*anal*" fistula, when the action of the sphincter ani forbids repair, its action must be paralyzed. In "*fæcal*" fistula, when obstruction to the bowel is present, the obstruction must be removed. In "*salivary*" fistula the salivary duct must find a natural outlet before its unnatural orifice can be expected to close. When any foreign body, tooth, or dead bone is keeping the sinus open, it must be removed. When a suppurating cavity at one end of the fistula continues to discharge, means must be taken to close it. When these objects have been achieved, attention may be directed to the fistula or sinus itself; and various are the means that can be employed for their cure.

Pressure in *recent* sinuses, to keep the parts in apposition, by means of pads, strapping, or bandages, is sometimes of use, the muscles that move the part being kept thereby absolutely at rest. In stumps and after mammary abscesses this practice is very beneficial.

Injection of some stimulating fluid, such as the preparations of iodine (either the tincture alone or diluted with one or two parts of water) will sometimes set up a healthy action: for the same purpose a *seton* has been used, and of all setons the small *drainage-tube* is the best, or a narrow coil of rolled gutta-percha. The *cautery* is sometimes of great use, and the galvanic is to be preferred. It can be accurately applied to the exact spot, and its heat maintained for any required time. It is generally most useful in small fistulæ.

Laying open the sinus is, however, as a rule, the surest plan, dividing it from end to end and keeping the sides asunder to allow of its healing from below. In superficial sinuses, where the skin is undermined, the thin overhanging portions should be removed; and this is best done with narrow scissors (Fig. 12). When done with a knife, the incision is to be made upon a grooved probe or director which has been previously introduced through the sinus. This, however, may often be done to great advantage with the wire of the galvanic cautery passed through the sinus on the grooved director or threaded in an eyed probe, the surgeon subsequently making traction on the two ends of the wire, made hot by contact with the battery, and dividing the tissues with a sawing motion. The division with the cautery has this advantage—that the surface of the sinus is so destroyed that it must granulate. There is, consequently, less need of careful dressing; and in old sinuses this is a point of importance,

FIG. 12.



Probe-pointed sinus scissors.

for their surfaces are so callous that they require to be scraped or otherwise rendered raw to excite granulations to form.

The division of a fistula with a ligature is now rarely performed, although with one of "india-rubber" it is feasible. In "bleeders" it might be called for, but in these the wire of the galvanic cautery is preferable when it can be obtained.

Dilatation of the fistula by means of a sponge or laminaria tent is often of value.

Plastic operations for the cure of fistulæ are also means of great value, particularly of vaginal and rectal fistulæ. These will be discussed in a future chapter.

Constitutional Treatment of Fistula.—Last, but not least, in the treatment of sinuses and fistulæ, constitutional treatment should be employed. In the fistula following operations such treatment is, as a rule, all that is wanted, and many are the cases in metropolitan hospitals of sinuses about stumps, skin wounds, or mammary wounds that will heal rapidly under the influence of fresh air, good food, and tonic medicine. In all cases these means are most essential, and with them and local treatment success is generally to be attained.

ULCERS AND SORES.

Ulceration is the result of an inflammatory process by which a *sore* or *chasm* is produced by the molecular disintegration of tissue the seat of cellular infiltration, the nutrition of the tissue being so disturbed by what is called the inflammatory process as to allow the chemical or disintegrating changes to have their way.

A sore is a chasm, a solution of continuity, caused by ulceration, the result of injury or otherwise, upon an external or internal surface of the body.

When a *sore* is being formed or is spreading by the process of ulceration, an *ulcer* is said to exist; when the ulceration has ceased, a *sore* remains.

Varieties According to Progress.—When an *ulcer* spreads rapidly, it is termed "*phagedænic;*" when it spreads by gangrene, "*sloughing;*" and when with this gangrene the molecular death of the tissue, or ulceration, is combined, "*sloughing phagedæna*" is said to exist. All these processes are consequently different varieties of ulcers, and are characterized by degrees of rapidity of the process, the simple ulcer being the mildest and the sloughing phagedænic the most severe form.

Varieties According to Condition of Ulcer.—A healing or cicatrizing sore heals by "*granulation,*" and the process is the same as it is in any wound the result of injury or operation. It may, consequently, assume many different appearances, and these have been considered under the heading of diseases of granulations, p. 62. Sores may, therefore, be *healthy, inflamed, weak, indolent, sloughing from excess of indolence,* or *irritable*—terms which are applied to granulating sores to express their conditions at the time, but which have no special signification; for these appearances fluctuate according to the general condition of the patient and the local treatment of the sore. A sore may also at any time take on the ulcerative process and spread, or may assume any of the other forms of spreading already described.

An Ulcer may have a Local or a Constitutional Cause.—Among the *local causes* of ulcers are injuries produced by blows, pressure, some chemical or irritating application, or some skin eruption set up or followed by inflammation and subsequent ulceration.

Amongst the *constitutional* causes, *excluding cancers,* may be classed anything that superinduces a low condition of the vital powers, such as any illness, scrofula, certain habits of life, syphilis, or scurvy.

A local ulcer or sore produced from local causes may, however, fail to heal from some constitutional defect, and a sore which has a constitutional origin may be kept up by local causes. Thus, a syphilitic or cachectic ulcer originating from a constitutional cause may take on any of the characters common to the local sore.

There are, likewise, special ulcers, such as lupus, rodent ulcer, epithelial or carcinomatous ulcers, to which attention will be drawn later on.

Local sores, as already stated, have a local origin—something exciting an inflammation and ulceration in the skin and a sore remaining—the disease being cutaneous from the first. The ulcer fails to repair either because its position is unfavorable for the process to be carried on or owing to some local peculiarity of the circulation of the part, such as varicose veins, or from some want of care in its local treatment or want of power in the patient.

Constitutional sores have rarely a cutaneous origin, unless they originate in some

ulcerating skin eruption, such as ecthyma or rupia. They almost always commence in the subcutaneous connective tissue as a more or less circumscribed induration, which lasts a very variable period and then softens down: the skin over it inflames, sloughs, and ulcerates, to give vent to a deeper slough, the sores or ulcers always being of a "*cellular-membranous kind*." These ulcers may have their cause in an ordinary cachexia or in syphilis, but the cellulo-membranous ulcer is *always* constitutional and requires *general* more than *local* treatment. In syphilis the ulcers are the result of broken-down subcutaneous "gummata." The appearance of these sores will depend much upon the period at which they are seen, but from the time when the skin has broken and ulcerated the margins of the opening in the skin will appear thin, irregular, and undermined, and at the bottom of the opening the slough will appear. When simple, the slough will appear more or less white, sometimes pearly; but when syphilitic, it will have the aspect of a *piece of wet washleather*—at least, in the majority of cases. When any of the slough has come away, the skin will at first be undermined and the margin of the sore will fall inward, but as the granulations rise from below the skin will be pressed up. When the wound has cicatrized, the scar will, however, almost always be a depressed, and in syphilis a stained, one.

Around this sore several small openings often coexist, each one having formed to give exit to a small slough, the margins of which appear as if they had been punched out. These sores occur mostly about the lower part of the thigh and knee, elbow, shoulder, and forehead; they are found, however, in any part of the body. The syphilitic are always surrounded by a *dusky* kind of inflammatory border, and are rarely painful: the non-syphilitic have a pinker blush. The washleather slough and dusky margin clearly indicate the syphilitic sore.

It is by no means uncommon to discover in such a sore the specific character of a disease that had been contracted some twenty or more years previously, and that had lain dormant after having manifested its presence by marked symptoms. Indeed, it is from the occurrence of such sores as these that the surgeon inquires whether constitutional syphilis is really ever cured—that is, eradicated—and whether a man once syphilized, as once vaccinated, is not so permanently altered as to show under certain conditions, with comparative certainty, that he is still under the influence of the poison, and that other diseases must for ever after be modified by its existence.

A healthy, healing, cutaneous sore is known by the small florid conical granulations that cover its surface and the healthy creamy pus thrown off from it. "In granulations new substances are formed, as if the earth was taken in heaps from one place and laid in another: the *thicker and smaller the heaps*, the better the granulations" (John Hunter, MS. lect., 1787). The granulations are not so vascular as to bleed or so sensitive as to cause pain on the slightest touch. The margin is natural, and where the skin and granulations meet a band of cicatrizing tissue is to be seen, assuming, where in union with the skin, a whitish line with a fine covering of epidermis (Fig. 50 B), but where in contact with the granulations a more vascular appearance than at any other part of the sore, the centre of the band being covered with a thin purplish-blue, semi-transparent film.

By the gradual and centripetal cicatrizing process of the outer border of the band and the gradual narrowing of its circle, the sore heals.

Treatment.—The surgeon's sole aim is to guard against anything that can interfere with the progress of repair. The treatment, consequently, is simple, a piece of absorbent lint, to protect the surface of the sore from injury, covered either with some antiseptic oily dressing, such as the terebene or carbolic oil, eucalyptol ointment, or a lotion of boracic acid, with the elevation and immobility of the part, being all that is required. The surface of the sore should be cleansed by means of a stream of tepid iodine water or a wad of absorbent cotton-wool

When the granulations are disposed to rise too high, dry lint may be applied, and at times a rub with lunar caustic hastens recovery. Small sores may be allowed to scab. Rest, with elevation of the limb, is always beneficial in aiding repair: but should this be impracticable, a good pure rubber bandage may be substituted, and a piece of thin sheet-lead bound over the sore outside the dressing gives efficient support and protection. In removing the dressing care should be taken not to injure the band of delicate cicatrizing tissue.

Deviations from Typical Sore.—Accepting this description as that of a healing sore, deviations from this type constitute the different forms that have been described. Thus, when the granulations assume a large, pale, elevated, watery appearance, the sore

is said to be "*weak*," the granulations in popular language being "proud flesh," the popular word "*proud*" being synonymous with *weak*. There is power in the sore to granulate, but the granulations have little power of cicatrizing; they are disposed, moreover, to slough on the slightest cause. These require local stimulants, such as the nitrate of silver in stick, sulphate of zinc or copper lotion, carbolic acid lotion in the proportion of two grains to the ounce, or terebene alone or diluted with one or two parts of olive oil. Dusting the surface with powdered alum or tannin is also sometimes beneficial.

The limb should be carefully elevated or bandaged, and the general health attended to.

The Indolent and Callous Ulcer.—When there is still less power in the sore, no granulations form; the surface puts on the appearance of a piece of mucous membrane, such as that of the pharynx, the sore being then called "*indolent*." At times a few weak granulations are found at one corner of its surface, but the greater part has a smooth and glassy aspect, with a thin and watery, but not purulent, secretion. Where the sore has existed long the edges will appear raised and indolent, covered with a layer of epithelium, and very senseless. It then acquires the term "*callous*," a callous sore being an indolent one of long standing. This indolent sore is always ready to take on a sloughing action on any slight cause, such as some general derangement of the health or the long assumption of the dependent position of the limb. It is common, indeed, to find the surface of the indolent sore "*sloughing*"—not, however, from inflammatory action, but from *extreme indolence in the granulating force*. Under these circumstances the surface of the sore becomes covered with a greenish, often fetid, secretion, the granulations as they form dying. When the sore is large, this appearance is more general toward its centre or lowest part; and as repair goes on the sore may cicatrize at its edges, where the granulations derive the full benefit of the vascular and nerve supply, while the centre of the sore still sloughs. In old people the margin of the sore may slough in one part and heal in another. Authors have described this indolent sore in the old as *senile ulcer*. These sores are very common, and are usually found in the lower extremities—often, too, associated with varicose veins; this condition of veins has, however, little to do with their origin, although it tends much to retard their recovery. These have been described by old authors as *varicose ulcers* simply from the fact of the two conditions being often found together. Such are almost always found in weak subjects with a feeble circulation.

The TREATMENT *of these indolent sores* consists in encouraging the venous circulation of the part by its elevation, and by pressure where this cannot be secured by rest, and by local stimulants and general tonic treatment. For pressure, there is nothing equal in value to the pure rubber bandage well applied, as recommended by H. Martin of Massachusetts in 1877 (*Trans. of American Med. Association*). When there is little or no action in the sore, the application of one or more blisters to the surface is very beneficial, or blistering liquid may be painted over its edges. When the surface is sloughing, half an ounce of carbolic acid or six ounces of terebene to a pint of olive oil, with or without the extract of opium, according to the amount of pain, forms an excellent application. Where the edges of the sore are indurated and callous, so that the cicatrization and contraction are almost impossible, the free scarification of the margin every half inch is often followed by a rapid change for the better, or two free incisions may be made on either side of the margin of the sore for the same purpose. During this treatment, if the venous circulation is assisted by raising the leg higher than the hip, the utmost good may be obtained. In private practice, when the leg can be dressed daily, the ulcer, with its dressing, and the whole limb may be covered with strapping. The strapping, therefore, ought to be good—not such thin material as that spread on calico nor thick felt strapping, but that spread on linen, such as is used at Guy's Hospital. The rubber bandage is, however, to be preferred to the strapping.

When the sore is painful or the patient has an irritable pulse, the beneficial effects of opium twice a day in a pill are very marked, and quinine, iron, nux vomica, or the vegetable bitters may be given, as the wants of the case indicate. The bowels also require attention, drachm doses of the sulphate of magnesia, with quinine, being a good aperient. When the sore is unusually large and there is little probability of the whole, from loss of skin, healing, fresh centres of *cutification* should be inserted by transplantation. In this way I have brought about the cicatrization of a large sore of twenty-four years' standing in three weeks, and many others of smaller size in an equally short period: indeed, by this practice of skin-grafting, I believe the necessity of amputation in the more severe forms of this affection will be greatly diminished, for, hitherto, indolent ulcers that surround a limb have ever proved themselves incurable, amputation being their only remedy.

All sores may inflame or become irritable, but there is an *inflamed sore* or *ulcer* which is found in subjects with thin and fair skins who are in some way reduced in power or "out of sorts," either from irregular living, overwork, or bad feeding. It appears as a small superficial, inflamed, irritable sore with a raw-looking appearance, an ash-colored slough, or thick secretion over its surface, and discharges a thin ichorous fluid sometimes tinged with blood. The patient will complain of its excessive painfulness, particularly at night, and will dread its being touched. It will look red and angry, though superficial. A blow or a graze may have caused it, or a local patch of eczematous inflammation preceded it, in which case it may be described as an *eczematous ulcer*.

The TREATMENT of these sores is very troublesome, the skin being usually highly sensitive. They always want soothing, and the best lotion is one of diacetate of lead mixed with the extract of opium; but this sometimes irritates, while the lead or zinc ointment gives comfort. At other times a cold bread poultice is the best application. In all cases the limb wants rest and elevation. In the eczematous sore, where the discharge from the eruption round the sore is profuse, the powdered oxide of zinc and starch, in equal proportions, may be used, or the surface may be washed with a solution of nitrate of silver in the proportion of ten grains to the ounce. Occasionally a solution of the extract of opium is the best lotion. Simple nutritious food, with a moderate allowance of stimulants, should be administered, but all high feeding is injurious. The general health mostly requires tonics of a non-stimulating kind, such as the vegetable bitters with alkalies, as the intestines are generally irritable. When the pain is severe, opiates and sedatives are indicated. In very inflamed ulcers the application of a few leeches at some distance from their edge occasionally gives relief. These sores are invariably obstinate.

Authors describe a *varicose ulcer*, but does such an ulcer exist? Many indolent sores are doubtless associated with varicose veins, and are probably indolent on account of this association; but how far they are really caused by them is a different matter, for varicose veins and ulcers of all kinds are constantly met with together. Of all ulcers entitled to the term "varicose," the eczematous has probably the most claim; for certainly eczema of the leg is a common consequence of varicose veins, and an ulcer the result of the eczema.

Practically, however, it is well to remember that when varicose veins exist *with* an ulcer repair cannot go on favorably unless the venous circulation of the limb be assisted by position or pressure, and that where these varicose veins are present all ulcers or sores, if neglected, are disposed to become indolent. When an ulcer takes its origin from an inflamed vein, the term is applicable in a measure, but this ulcer has no special characteristics.

Sores that are prevented from healing by varicose veins must be treated by the elevated position of the limb or by the use of the rubber bandage or strapping, and in bad cases by the obliteration of the veins. Without this obliteration the treatment will of necessity fail; whereas with it the sore may be expected to heal with the use of such general and local means as its nature may require.

How far it is right to heal an old chronic sore has not yet been quite decided. Older surgeons declared it to be inexpedient, as cases were met with in which apoplexy or some other alarming condition supervened. Modern surgeons, however, are disposed to question the explanation of these facts, and to look upon that practice as beneficial which removes any abnormal condition, local or general. Still, it is wise, when a patient has been in the habit of losing by discharge from the surface of a sore a certain amount of material which would otherwise have been used to maintain the general powers, to cut off the supplies in another way, to order more abstemious living, and to regulate the bowels by some saline water, natural or artificial, as may suit the stomach.

Sloughing and phagedænic sores are rarely seen except in connection with syphilis or hospital gangrene. In syphilis sloughing is found in the intemperate and ill-fed, and mostly in gin-drinking prostitutes. It attacks any surface that has been made sore either from venereal contact or other causes, and it is marked by the rapid way in which the process destroys tissues, by the fœtid character of the discharge, the great depression of power which is an invariable accompaniment, and the constitutional disturbance.

Opium in full doses is required for their TREATMENT, with tonics and good nutritious food. When these means do not control the ulceration, the application of strong nitric acid with a piece of wood to the surface of the sore is often useful; sometimes, too, the local application of iodoform, iodine, or bromine in solution is of great benefit. Fresh air is always indicated, and abundance of disinfectants, such as Condy's fluid, terebene,

or carbolic acid in some of its forms. These sores are mostly due to some feeble constitutional condition, and not to a local cause, although at times the action seems local, when the application of some powerful escharotic, such as nitric acid, is called for.

Sir J. Paget describes *cold ulcers:* "They are like small inflammatory ulcers occurring spontaneously in the extremities, especially at the ends of the fingers or toes or at the roots of the nails. In some cases they are preceded by severe pain and small gangrenous spots. They are in many respects like ulcerated chilblains, but they occur without any exposure to intense cold in patients whose feet and hands are commonly, or even habitually, but little warmer than the atmosphere they live in. Such patients are among those who say they are never warm, and the skin of their extremities, unless artificially heated, is to the touch like the surface of a cold-blooded animal. With this defect, which is common in women, there is a small feeble pulse, a dull or half-livid tint in the parts which in healthy people are ruddy, a weak digestion, constipated bowels, and scanty menstruation.

"The cure of the ulcers and prevention of their recurrence lie in the remedy of these defects. Many tonic medicines may be useful, but the most so is iron; with it purgatives are generally necessary—*e. g.*, small doses of mercury and aloes or sulphate of magnesia. Full diet, exercise in the fresh air, dry warm clothing, especially of the lower half of the body, and warm bathing are required; dry applications or lotion of sulphate of zinc or copper are the best local means, and the part must be kept warm; healing is always tardy at a low temperature."

Allied to cold ulcers are those formed on fingers or other parts which have been deprived of their nerve supply by some injury.

Scorbutic Ulcer.—In Sir J. Paget's able article in Holmes's *System* occurs the following description of the scorbutic ulcer by Mr. Busk: "Although scurvy in itself cannot be said to be attended with any peculiar form of ulceration, ulcers or sores of any kind already existing from other causes assume, in consequence of this scorbutic taint, a more or less peculiar character, and when thus modified have been usually termed 'scorbutic ulcers.'

"Scurvy essentially consists in an alteration in the constitution of the blood which leads to the effusion into the various tissues of a *fibrinous exudation*, usually deeply colored, and which has on that account been commonly regarded as a simple coagulum. That this effusion, however, can scarcely be regarded in this light is proved by several considerations, but more especially by the circumstance that it is from the first *solid* and *capable of becoming imperfectly* organized—that is to say, it is after a time permeated by newly-formed vascular channels. It is the presence of this effusion which causes the spongy swelling of the gums, the tumefaction and induration of the intermuscular tissue, the so-termed *scorbutic nodes*, and which, when poured out on the surface or in the substance of the corium, constitutes the vibices and petechiæ so characteristic of the disease. It is the *effusion, also, of the same semiplastic material on the free surface of sores or ulcers which gives them the peculiar aspect termed scorbutic.*"

"Ulcers of this kind are distinguished by their livid color and irregular tumid border, around which no trace of cicatrization is evident, whilst the surface of the sore is covered with a spongy, dark-colored, strongly adherent, fœtid crust, whose removal is attended with free bleeding and is followed by a rapid reproduction of the same material. This crust, in bad cases, as remarked by Lind, attains to a 'monstrous size,' and constitutes what has been appropriately termed by sailors 'bullock's liver.'"

The Syphilitic Superficial Sore.—The deep cellulo-membranous syphilitic sore has been already described (page 74), under the heading of constitutional sores, but the *superficial, cutaneous, rupial syphilitic* sore deserves notice because it is very common. It mostly succeeds an ecthyma or rupia, is mixed with the eruption in some other stages, and is simply an ulceration of the base of a syphilitic eruption. This goes on increasing irregularly in a serpiginous form, the sore healing in one place and spreading in another, but it involves only the skin. The edges of the sore—or sores, for they are often numerous—are usually well defined, and frequently irregular; the surface, too, is generally of a deep color, and when healing may either scab or granulate, as any other sore. They are met with at any period after the first constitutional symptoms of syphilis have passed away, and occasionally at a remote date; they are always found in a cachectic or enfeebled subject; indeed, it appears as if want of power allowed the disease to manifest itself in the new form.

The treatment of these sores, when once they have been recognized, is not usually difficult. Tonics, with the iodide of potassium or sodium, in doses of from three to ten

grains, usually effect a cure—at least, for a time; liquor cinchonæ and compound spirit of ammonia in half-drachm doses are also good remedies. In other cases the mineral acids, quinine, or iron is indicated. Mercurial remedies are sometimes, though rarely, necessary; and of these the perchloride of mercury, in doses of one-sixteenth of a grain in bark, green iodide in one-grain doses in a pill, or the mercurial suppository, are the best forms to employ.

Locally, the sores may be dressed with any simple dressing; but when indolent, a mercurial lotion, as the black wash, is the best.

Lupus, for convenience' sake, must be classed amongst the ulcers. It is met with in two forms—the "*lupus erythematosus*" and the "*lupus vulgaris*," the latter being more common in young scrofulous subjects, and the former in the middle-aged. When associated with a spreading ulceration, it has been called "*lupus exedens*."

The "lupus erythematosus" occurs chiefly upon the face and is symmetrical; each patch has well-defined edges and a red, scaly surface, with small horny points upon it, due to accumulation in the dilated mouths of sebaceous ducts. The "lupus vulgaris" has its origin in a skin tubercle, or tubercles, of a flat form, fleshy consistence, and pink shining appearance; and these at times ulcerate. This lupus ulceration, when once originated, progresses steadily, destroying every tissue it attacks, and when it reaches the nose—its very favorite seat—it simulates cancer. The surface of the sore is sometimes free from all signs of granulations and often very irregular, while the edges are ragged, raised, and often everted. It is painless. The tubercles themselves feel spongy, are neither so hard nor so well defined as cancer; they are composed of granulation tissue.

These lupus ulcers are more commonly found on the face than elsewhere, and probably next in frequency on the female genitals. They are most destructive when left alone, but often very amenable to treatment. In young adult life they are more common than in the old, and appear closely allied to tuberculosis.

Treatment.—Although the disease has probably a constitutional origin and requires tonic treatment, both by medicine and regimen, there is no disease that derives more benefit from local treatment. When the ulceration is *superficial* and the skin is not deeply infiltrated, the local application of cod-liver oil on lint and the covering up of the part with cotton-wool to keep it warm at times works wonders. But under other circumstances, when the skin is *deeply* involved and infiltrated with disease, the free removal of the whole growth is the most efficient treatment; and this may be carried out by carefully scraping the surface of the growth or by destroying it with the cautery or caustics.

The most successful method is unquestionably the scraping, so long as it is done boldly and effectually, for every particle of infiltrating tissue must be scraped away; and a blunt knife or a sharp spoon is the best instrument to use. After scraping, it is well to dress the wound with lint soaked in liquid carbolic acid. If a healthy action follows the operation, all is well and the parts will heal under a dressing of cod-liver oil. If any signs of disease reappear, the sharp spoon should be at once reapplied.

When scraping is rejected, the free use of the electric or gas cautery may be substituted; and, so long as the local disease is effectually destroyed, the choice of means is not very material. These means, however, have entirely set aside the use of escharotics. In exceptional cases excision may be beneficial.

BED-SORES.

In theory bed-sores should never occur, yet in practice they appear in certain cases in spite of the greatest care and attention. It is well, however, for the surgeon to act upon the theory, as by so doing he is stimulated to do everything in his power to guard against their occurrence; and no better illustration of the old adage, "Prevention is better than cure," could be found than in such a case.

Bed-sores may briefly be described as the death of a part from mechanical pressure, the parts involved in some cases literally dying from being deprived of their nourishment by prolonged and continued pressure; in others, from some inflammatory action induced by it.

Bed-sores may arise in healthy subjects who are kept unmoved for ten or fourteen days, but in the old, the fat, or very thin they may occur at an earlier date, as they do in fever cases of all kinds, and in spinal or partially paralytic cases; completely paralyzed parts are less prone to slough than the partially paralyzed.

Dirt and moisture, under all circumstances, accelerate their appearance.

A bed-sore may appear as a simple abrasion, a sloughing of the skin or subcutaneous

tissue, and in severer cases the exposed bone may die, and in the worst the spinal canal may be opened.

TREATMENT.—Since, as a rule, they are caused by continual pressure on a part, they may very generally be averted by some change of the patient's position. The necessary amount of movement may, as a rule, be allowed in all medical and in most surgical cases, but local pressure under all circumstances should be periodically relieved.

The skin of the part pressed upon should be hardened by washing it at least twice in the twenty-four hours with some camphor spirit and water, vinegar and water, or nitrous ether and water, in the proportion of one part to three. An artificial covering of the flexible collodion is occasionally of great use.

When the parts are about to slough, these applications, however, are useless, and nothing but the removal of pressure will suffice. With this object, well-filled water beds and water or air cushions should be employed. I have found a mattress divided transversely into three parts and a water cushion substituted for the middle section of great use. At other times the sections of the mattress may be simply separated for a few inches in the line of pressure.

In spare patients, where the spinous processes of the vertebræ are prominent, thin slips of felt plaster placed vertically down the back give great relief, and the same plaster applied to other painful parts is of value; cushions of amadou and well-adjusted pads of cotton-wool or spongio-piline are also always of service.

When sloughing is present, a linseed-and-bread poultice with a solution of carbolic acid, of iodine, Condy's fluid, or charcoal sprinkled upon the surface is the best application, though a carrot or yeast poultice occasionally cleans the wound.

When the slough has separated, some stimulating lotion or ointment may be required; and this is best applied on cotton-wool. The glycerine of boracic acid or a lotion of chloral, gr. x to the ounce, is the best application.

In all cases where patients have to rest for a lengthened period, careful attention should be paid to keep the bed smooth and the sheets free from rucks. Corded or feather beds should not be used. The best is a horse-hair mattress placed upon a second or spring bed.

MORTIFICATION, TRAUMATIC, ARTERIAL, AND VENOUS.

The mortification of any part of the body signifies its death. When a soft part is "dying," it is said to be in a state of "gangrene;" and when "dead," in that of "sphacelus." The dead portion is called a "slough," and the process of separation the act of "sloughing." When bone is dead, the term "necrosis" is employed, the dead portion being called the "sequestrum" and the process of its separation "exfoliation."

The dead portion of any tissue is thrown off from the living by means of ulceration; and when the slough has separated, the parts heal by granulation, as an ordinary wound. In the "sloughing phagedæna" the two processes of ulceration and sloughing are combined, the molecular death of a part, or ulceration, going on with the more general destruction of gangrene.

Cases of mortification may be divided into three main groups according their causes—viz.:

Traumatic; anæmic, or *arterial;* **static,** or *venous.*

Traumatic gangrene includes cases brought about by external violence or chemical action, the term "*direct*" being applied to those in which the vitality of the part is destroyed at once, and "*indirect*" where the same result is brought about by the inflammatory action which follows an injury.

Anæmic or arterial gangrene includes cases in which a part is starved from the obstruction of its artery, either from operation, accident, or disease.

Static or venous gangrene includes those in which stagnation of blood is caused by the mechanical arrest of the circulation through the veins, complicated or not with secondary inflammatory action.

In each and all of these groups inflammation plays directly or indirectly an important part.

Moist and Dry Gangrene.—When mortification takes place in tissues that are filled with blood, and more particularly with inflammatory fluids, "moist, hot, or humid gangrene" is produced; but when it take place in parts in which no such stasis exists, and where death of the tissues is the result of a want of arterial supply, "dry, cold, or chronic gangrene" is caused. These two forms, however, are in a measure convertible,

the rapidity of the process and the amount of inflammatory infiltration influencing the result.

Tissues suffering from defective nutrition, either as the result of some want of nerve supply or energy or of extreme debility the consequence of severe illness or other depressing influence, are more prone than others to mortify on slight causes.

Direct traumatic gangrene is well exemplified in the destruction of skin from the contact of a corrosive acid, such as sulphuric or nitric, in bad burns and "smashes." It is also well illustrated in cases of extravasation of urine or fæces, and probably also by the action of some animal poisons.

Indirect traumatic gangrene is also well seen in the integument after the application of a blister to a child or feeble patient, the blister being followed by inflammation of the blistered part and its subsequent death. It is more frequently met with, however, in bad compound fractures in which the limb swells a few days after the accident and the skin assumes a mottled and livid hue; loose blisters or phlyctenæ of raised cuticle appear on the surface, containing more or less bloodstained serum, and the tissues become sooner or later cold and insensible, the temperature of the part often falling rapidly. The fluids from the wound, likewise, soon become offensive, blood-stained, and mixed with gas, and the tissues crepitate on pressure from its presence.

Line of Demarcation.—The gangrene may be limited or spreading. When the action has attained its limit, a defined vascular line, "the line of demarcation," appears where the living tissues come in contact with the dead. In this vascular line ulceration takes place, and if left to take its course leads to the separation of the slough from the living tissues. By it soft parts, and even bone, may be divided, the granulations, as they spring up during the process of repair, materially assisting the casting off of the slough. When the deeper tissues of a limb are thus affected, they rapidly decompose and give rise to a horrible fœtor, the extent of decomposition depending much upon the fluids in the part. Should the limb be exposed, the integument will dry, become black, and gradually wither, while the soft parts beneath will undergo decomposition.

This process is rarely attended with hæmorrhage, the vessels becoming obstructed by the coagulation of their blood during the sloughing action. In exceptional cases, however, the vessels give way, the more rapid the sloughing action in the part, the greater, apparently, being the liability to bleed.

Anæmic Gangrene.—The best examples of this group are found after the application of a ligature to a large artery, such as the femoral, for aneurism or injury; after the contusion or stretching of an artery (*vide* Fig. 134) or its embolic plugging. In all these instances the part dies by starvation from want of blood; and the more sudden the act by which the supply is cut off, the greater is the probability of gangrene being the result. The more gradual occlusion of an artery, except in the aged, is more rarely followed by such a result, the collateral circulation preventing it. In the form of gangrene called "senile" it is very probable that arterial obstruction, the result of atheromatous arterial disease or of embolic plugging of the vessel from the breaking loose of some portion of the diseased arterial coats, is the immediate cause of the gangrene; but the feebleness of old age, the degeneration of the tissues that have been badly supplied with arterial blood, coupled often with some slight local injury, are doubtless powerful agents in giving effect to the process. One or more of these agents may be the true cause of the gangrene, but in the majority of cases they are probably combined. When the gangrene is purely a dry withering or mummifying process, the cause is probably the simple want of blood supply; but when inflammation coexists, the gangrene will be moist, the feebly-nourished tissues, either from injury or otherwise, becoming inflamed from some accidental cause, and ultimately dying.

In the gangrene met with from arteritis or embolism in the young or middle-aged, the dry form is the usual, the parts becoming cold, bloodless, waxy, rapidly withering, turning black, and then mummifying. When caused by embolism, the onset of the gangrene, or rather the early indication of the plugging of the vessel, is marked by a sudden shooting or crampy pain down the extremity, this symptom being speedily followed by those of "arterial gangrene."

When the occlusion of the vessel is gradual, this pain is not present and the symptoms of gangrene are more chronic.

Gangrene from "cold" may be the direct result of want of blood supply, or may be indirectly caused by the inflammation due to excessive reaction *from* cold; this latter form is called secondary mortification. Gangrene following the use of the "ergot of rye" is dry, and follows precisely the same course as when due to arterial obstruction.

Static Gangrene.—The best illustrations of this variety of gangrene—which results *from obstruction*—are seen in cases of strangulated femoral hernia; where splints are too tightly applied; after the prolonged employment of the tourniquet to check hæmorrhage; in a tight paraphymosis; in sloughing of protruding piles; in the gangrene of a limb from the pressure of an aneurism or tumor upon the chief venous trunks; in the sloughing of the legs, groins, or other parts of patients suffering from some obstructive heart disease. In all these the parts may die from blood stasis mechanically produced, though inflammation more or less marked, with its products, has generally an important influence in producing the result.

Mortification is thus a compound process, and is brought about by mixed causes, direct injury, want of arterial supply, and blood stasis from a mechanical obstruction to the return of the venous blood being the three chief. At the same time, in each of the three classes of cases inflammatory action has secondarily an important influence. Feebleness of power from old age, want of nutrition, or deficient nerve supply in a part at the same time renders a patient or tissue more prone to the action of these causes, and the process more active.

The constitutional symptoms associated with gangrene vary with its cause, but under all circumstances a depressed condition of the ordinary powers is recognizable. In traumatic inflammation, during the stage of excitement, the pulse may be rapid and the beat strong; there may be high fever and other symptoms indicative of sthenic action; but when about to terminate in gangrene, all these symptoms will be marked by a sudden fall of the temperature of the body—say from 104° or 105° to 99° F.[1]

When the mischief is extensive and the gangrene spreads, what are known as typhoid symptoms may supervene. In the more acute cases death takes place very rapidly, but in the chronic the constitutional symptoms are negative.

Treatment.—The most important point the surgeon has to bear in mind in the general treatment of every form of mortification is that the condition indicates a depressed state of the system; consequently, his efforts should be directed toward maintaining the patient's strength and cautiously building up his feeble powers by means of nutritious food, stimulants, and tonics, allaying pain, at the same time, by local and general soothing remedies, such as opium, morphia, or chloral, since nothing depresses more than pain.

In the local treatment of gangrene its cause has closely to be considered. To treat a case of gangrene the result of a local injury as one due to an obstruction of an artery would be clearly wrong, and to deal with an example of this latter form in the same manner as with another due to blood stasis the result of mechanical obstruction to the return of the venous blood of a part would be unscientific. I shall, therefore, consider the question of treatment as applied separately to the three groups of cases already formed.

Treatment of direct traumatic gangrene, when of a *limited* nature, need cause but little anxiety. It should be treated on ordinary principles of local cleanliness, poultices, and irrigation, or the local application of absorbent cotton, with some antiseptic lotion such as iodine lotion, sulphurous acid, Condy's fluid, carbolic acid, or chloride of zinc, is all that is needed. When the slough has come away, the surface is to be treated as an ordinary sore.

When the gangrene is more extensive and involves possibly a portion of a limb, *but yet defined*, the expediency of removing the dead part by amputation is not to be disputed. No more of it, however, should be sacrificed than is absolutely necessary, and to ensure this object the flaps to cover the end of the stump may be cut of any shape. Thus, in gangrene of the leg it is better to amputate below the knee with any form of flap that can be made of sufficient size to cover in the end of the stump than at the joint, and it is far better to amputate at the joint than above it.

The *treatment of indirect traumatic* or inflammatory gangrene is full of difficulties, more particularly when seen in a case of compound fracture, since to remove a limb at once, as soon as the action has declared itself, would be to take away what often might be saved or to do that which will not arrest the disease; and, on the other hand, to defer the removal too often diminishes the prospect of recovery, the extension of the mischief rendering the amputation a more formidable one or precluding the possibility of its performance. *It is wise, however, in all cases, to amputate when the gangrene is extending, owing to the infiltration into the healthy tissues of the decomposing fluids from the parts.*

In a case of compound fracture which is so bad as to suggest the necessity of primary amputation, but in which the surgeon has been desirous, if possible, of saving the limb,

[1] Peck, *St. George's Hospital Reports* for 1868.

the first onset of an inflammatory action that assumes a gangrenous form should be met by amputation; while in a case less severe, where the injured limb has a good prospect of being made a useful one, an attack of inflammatory gangrene need not necessarily lead to its loss.

Where the gangrene is due to the injury, it will probably be limited, and may so terminate that a good limb can subsequently be secured. Where it is due to constitutional, and not to local, causes, amputation of the limb will not arrest it; for the gangrenous action will in all probability attack the stump and continue till it finds a limit or destroys life.

When the gangrene originates from a local cause, amputation is clearly the best practice; but when from a constitutional cause, it had better not be entertained till the action has ceased and a limit to the disease been formed. In military surgery there may be many reasons why this practice cannot be observed, for all conservative surgery or treatment based on expectancy has to be sacrificed to the exigencies of the moment.

How, then, it may be asked, is spreading gangrene to be treated? I reply, By maintaining the part as free as possible from all fœtid discharges and employing incisions when necessary to secure these ends, by local cleanliness and the use of antiseptic applications, and internally tonics and good food.

Under this practice, when nature is strong enough to check the progress of the disease, a limit to its extent will be formed and the local affection will be amenable to treatment; but when no limit takes place, death will ensue, which amputation would not have arrested.

When amputation is deemed necessary on the arrest of the action, the limb should be removed as close as possible above the diseased part. There exists no necessity to sacrifice any tissue, and much less a joint, to make an amputation neat. The only point for consideration is that the diseased tissues should be avoided, but beyond these no healthy structures should be sacrificed.

The Treatment of Anæmic or Arterial Gangrene.—The surgeon's object should be to prevent its extension, and to assist, when called upon, the separation of the parts.

To carry out the first of these, the mortified parts may be wrapped in some lint dipped in simple or carbolized oil; and the whole extremity should be raised, to encourage the venous circulation, and surrounded with cotton-wool, to maintain its warmth.

A liberal allowance of bland nutritious food should be given, aided with stimulants and tonics to assist digestion; the circulation, too, should be sustained, though anything like overstimulating is reprehensible. Opium also may be given to allay pain, the patient being kept gently under its influence. Where small parts only are implicated their separation may be left to nature, but where hands or feet are involved in the gangrene the surgeon should assist nature's processes by amputation above or about the line of demarcation as soon as indicated.

When a limb dies from embolic plugging, occlusion of an artery, or from the effects of ergot of rye, amputation may be performed as soon as the line of demarcation has been indicated—that is, provided the general condition of the patient be such as not to forbid it. In "senile gangrene" the interference should be of the mildest kind.

Where "sphacelus" takes place after the application of a ligature to a large artery, early amputation is sometimes called for, it being at times wise to remove the limb above the line of ligature rather than to wait for nature to indicate the point, particularly when the limb is œdematous from blood stasis and infiltrated with inflammatory products, this practice saving much constitutional disturbance and economizing power. In cases, however, in which the gangrene assumes the anæmic form and spreads slowly, a line of demarcation may be waited for, more particularly when the constitutional condition of the patient is good.

In the treatment of the third group of cases, those of "static gangrene" caused by the mechanical obstruction to the return of blood from a part, the first thing to be done is to remove the cause. In hernia this is accomplished by dividing the stricture; in paraphymosis, by freeing the prepuce; and when the result of the application of a tourniquet or splints, by their removal. By this course, if the parts involved are not irreparably lost, a recovery may take place by natural processes, their venous circulation being aided by position and other means. When gangrene, however, has taken place in a limb, its early amputation is necessary, it being wiser to remove the dead part at once before the setting in of secondary inflammation, which may spread and cause more loss of tissue, the point of application of the mechanical force fairly indicating the extent of mischief.

In gangrene of a limb from a ruptured artery or aneurism the same practice should be resorted to, for similar reasons, delay, under all the circumstances, being unnecessary as well as injurious.

HOSPITAL GANGRENE,

or sloughing phagedæna, is an affection that attacks wounded or injured parts, and chiefly in overcrowded, badly-ventilated, or ill-drained hospitals. At times it presents itself as if generated in a ward too closely filled with patients who have suppurating wounds; at others, as if conveyed into a ward by the introduction of a sloughing or fœtid sore. Want of cleanliness in the treatment of suppurating wounds and want of attention to sanitary laws have undoubtedly much to do with its propagation, for the disease seems to be contagious as well as infectious, through its discharges. Its contagious character is admitted by all, though some dispute its infectiousness. Guthrie, however, in his *Commentaries*, relates the following striking fact bearing upon the point: "Burgmans says that hospital gangrene prevailed in one of the low wards at Leyden in 1798, whilst the ward above it was free. The surgeon made an opening in the ceiling between the two, in order to ventilate the lower or affected ward, and in thirty hours three patients who lay next the opening were attacked by the disease, which soon spread through the whole ward."

Two forms of the disease exist. In one the gangrene takes place by small sloughs and the ulcerative action is the more violent; wounds attacked with it rapidly spread, and skin, subcutaneous and connective tissues all disappear under its action. Blackadder relates how a vesicle forms and ulcerates and the ulceration rapidly spreads, leaving a sharp well-defined edge to the ulcer. This form of the affection Delpech designated "ulcerous," and Boggie "phagedæna gangrenosa."

In the second form the tissues die in masses, forming pale, ash-colored, pultaceous, horribly offensive sloughs, these sloughs giving the old term "putrid degeneration" to the disease. In one epidemic the ulcerative form will predominate; in another, the sloughing; and at times it appears as if one form of the disease would give place to the other. As a rule, though not always, an open wound seems requisite for the disease to fix upon. In 1849, when the wards of Guy's Hospital *last* contained such cases, a contused part often took on the action, and the gangrene commenced as a vesicle the base of which turned at once into a grayish slough, which rapidly extended. When it attacked a wound, the edges or surface would first cease to secrete, then assume a gray color and slough; and this action would spread, small wounds becoming large even in twenty-four hours. When the slough had ceased to spread, ulceration would throw it off; and the fœtor of the slough, with the *débris* of the ulcerating tissues, formed a mass of decomposing material unequalled in any other affection. Skin readily died under the influence of the process on the connective tissue, and muscles became involved; tendons and vessels gave way only in prolonged cases, and hæmorrhage was rare.

The constitutional symptoms of the disease in the epidemic I have witnessed were absent at the outset, and there was certainly neither fever nor other disturbance to indicate the approach of the action: yet when the local disease had once manifested itself, great depression became very general. It was always remarked, however, that the constitutional symptoms were never in proportion to the extent of the local affection. When strong subjects were attacked, the local mischief told but little upon their powers; while with feeble subjects the effects were more marked.

Military surgeons, however, have related that the constitutional often preceded the local symptoms. Hennan states this very clearly, and Thompson of America found a like result: while Blackadder, Delpech, Guthrie, and Macleod found the local affection took precedence in point of time.

It would rather appear, from the descriptions given of the epidemic at various times, that the ulcerative form is more commonly preceded by constitutional symptoms than the sloughing, the sloughing being, apparently, a local affection at the first.

During the late German campaign Professor Billroth met with a wound disease which he had not seen before, and which he terms "diphtheritic phlegmon" or "diphtheritic infiltration;" and he describes three cases in which the diphtheritic appearance occurred soon after operations and was speedily followed by fatal collapse. In these the surface of the wound assumed a pale-gray or white color, and the entire muscular structure of the part became hard and stiff from an indurated infiltration. The affection was distinguished from gangrene by an absence of any rapid increase of the ulcerative process or of inflammatory redness in the vicinity, and by the surface of the wound exhibiting a lardaceous gray or whiteness, and not the greasy pulpiness of hospital gangrene. The broad, hard infiltration so soon following the operation might seem to be due to contagion by means of the dressings employed, but this was scarcely probable. In its sporadic form it especially appears to affect the subjects of septic or pyæmic disease,

and perhaps certain conditions of the secretions inclined to coagulation may favor its production.

Treatment.—*Abundance of fresh air*, as maintained by a constant current allowed to pass through the ward or room, is most essential, with isolation, the free use of antiseptics and close attention to all sanitary measures. During the early stages of the disease irrigation seems to be the best local treatment, with the removal of *all sloughs and putrescent material* by carefully cutting the existing slough with scissors or scalpel aided by the dressing-forceps and mopping the surface of the wound with cotton-wool or tow, thus *thoroughly cleansing the whole surface of the wound*. The next aim is to prevent the extension or return of the sloughing, by means of local applications; and of these nitric acid was formerly the chief, the acid being freely applied to the diseased parts and carefully introduced into every hollow and excavation into which it could percolate.

To apply the acid, writes Welbank, "the sore must be thoroughly cleansed and all its moisture absorbed by lint or tow. The surrounding parts must next be defended with a thick layer of ointment; then a thick pledget of lint, which may be conveniently fastened to the end of a stick, is to be imbued with the acid, and to be pressed steadily on every part of the diseased surface till the latter is converted into a dry, firm, and insensible mass. The part may then be covered with simple dressings and cloths wet with cold water."

Dr. Goldsmith of America, and others, have spoken very highly of the value of bromine as an application which arrests ulceration and turns sloughs into tough deodorized tissues. It should be applied freely to the whole surface, and its application should be repeated when the sloughing or ulceration spreads. Iodine, carbolic acid, and the oil of turpentine have also been advocated; and the latter, it is said, has the power to dissolve the sloughs and change the action of the disease. Delpech and some surgeons speak highly of the actual cautery; and when the benzoline cautery is to be had, it might be used. The object of all these different plans of treatment is to excite a new action on the surface of the wound, and to destroy the sloughing tissues which, doubtless, by mere contact, have a power of keeping up or propagating the disease.

When the sore is extensive, an anæsthetic should be administered during this local treatment. After the cauterization the surface of the sore should be dressed with carbolic or terebene oil; whilst laudanum, iodine lotion, or bromine in solution, two drops to the ounce of water, is also beneficial.

Dr. Packard of Philadelphia used powdered sugar or thick syrup, sugar being a hydrate of carbon which does not give up its oxygen. He dusted the parts with the sugar and covered the whole with wet lint. When odor exists, charcoal should be mixed with the sugar.

The constitutional treatment consists in abundance of light, nutritious food, milk being administered as freely as it can be taken, with sufficient stimulants to maintain the circulatory system and assist digestion.

Tonics, such as quinine and iron, are often well borne in large doses, five grains of the former dissolved in half a drachm of the tincture of the perchloride of iron being a good recipe; or when quinine cannot be taken, the tincture of nux vomica in ten-drop doses may be substituted. Opium is an admirable drug when the ulcerative action is present, but in the sloughing stage it is not so satisfactory. Chloral is probably a good remedy for a like purpose.

ERYSIPELAS.

Erysipelas is a contagious and infectious specific disease due to the presence of some blood poison that has probably been introduced into the body from without. It is intimately allied with other blood poisons, such as are found in scarlet or puerperal fevers or septicæmia in any of its forms; for these poisons seem to be convertible. It is connected with defects of drainage or ventilation, but is not so much a hospital disease as is generally believed, only 186 cases having taken place in Guy's Hospital in the eight years ending with 1879 out of 18,922 surgical patients which were admitted, or less than one per cent. No less than 451 cases were, however, admitted *with* the affection, and some of those recorded as having been transferred from one of the wards simply passed through it.

It manifests its presence in three forms—as a diffused cutaneous inflammation, "simple cutaneous erysipelas;" as a diffused inflammation of the cellular tissue, "diffused cellular inflammation;" and as a diffused inflammation of both skin and cellular tissue combined, "phlegmonous erysipelas;" the latter two being included in the expres-

sion "cellulo-cutaneous." The state of the system, the temperature and habits of the individual, have much to do in determining the form of the affection. When the disease follows an injury, it is called "traumatic;" when it occurs spontaneously, it is styled "idiopathic."

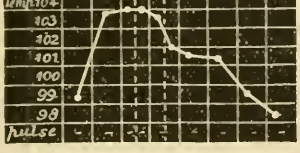
The peculiarity of erysipelas lies in the diffused character of the inflammation and in its atonic nature. It is both *infectious* and *contagious*.

The attack is occasionally preceded by some constitutional disturbance, but as often as not such has not been observed; the severity of the general symptoms, moreover, in no way bears any proportion to that of the local disease. Febrile symptoms ushered in by chilliness and *rigor* are the most common, the tongue being probably foul and the bowels either constipated or relaxed. As the disease advances the fever runs high and delirium of different forms appears; the pulse becomes quickened; if full, it will always be compressible, and often irregular or intermittent. Toward the close of the disease, particularly when terminating unfavorably, the pulse will be small and weak. The temperature at the first onset of this disease, as a rule, rises rapidly, and in its decline falls as fast (*vide* figs. 13 and 14). When the temperature remains high, a bad prognosis should be given.

C. de Morgan, Nunneley, and H. Bird assert that if the pulse rise in frequency after the sixth or seventh day it is a very bad sign. I cannot, however, endorse this observation, although, as the end of the first week is about the time that complications appear if they occur at all, it may possibly be correct.

Frank has pointed out that when a patient has had febrile symptoms for some hours attended with pain, tenderness, and swelling of the lymphatic glands of the part, there is

FIG. 13.



Thermograph of erysipelas supervening upon removal of the tarsal bones after the traumatic temperature had subsided, showing rapid elevation of temperature—nearly 5 degrees—at the onset of the disease and steady fall during convalescence. Case of H. B., æt. 32.

FIG. 14.

Thermograph of erysipelas in man, æt. 29, after removal of parotid tumor. Operation (day 1) followed by slight traumatic fever (day 2) and steady fall in temperature. Elevation of temperature (day 4) when blush first became visible, and steady rise for three days during increase of disease, with rapid fall on its subsidence. Convalescence on eleventh day.

no doubt that erysipelas is coming on. Chomel held the same view, and Campbell de Morgan relates "that Busk is so convinced of the invariable occurrence of affection of the glands before erysipelas appears as to consider it a pathognomonic symptom," and he believes that, although the blood became affected, the actual primary seat of the local inflammation was in the absorbent system. Sometimes swelling and excessive tenderness of the glands precede by many hours the appearance of a blush on the skin. These views accord well with those which Dr. Bastian brought before the Pathological Society in 1869, based on the post-mortem examination of a man who died from erysipelas in a state of delirium and stupor. In this case, finding the small arteries and capillaries of the brain plugged with embolic masses of white blood corpuscles, he suggested this condition as the cause of delirium. He stated "that the blood change is a general one, and through every part of the body this blood is carried with its rebellious white corpuscles; so that we may expect that in all organs alike the same obliterations of small arteries and capillaries take place." Thus, when those of the liver are involved jaundice may be produced, and when those of the kidney albuminuria, these conditions being occasionally found in erysipelas.

If we accept Dr. Bastian's observations pathologically, and look to the condition of the white blood corpuscles for an explanation of many of the phenomena of erysipelas, we may fairly admit the inference from clinical observations respecting the absorbent system to which Frank and Busk have called our attention, for the glands of this system and the white blood corpuscles are generally recognized as having a close relationship. These views receive much confirmation from the pathological observations to be read on page 87.

Local Symptoms.—In the *simple* form of cutaneous erysipelas mere excess of vascularity, as indicated by the vivid redness of the part affected, is the chief local symptom, and with this there is a sensation of heat or tingling in the part, and in rare instances

the formation of small vesications. The border of inflammation is invariably well defined. The redness, which spreads rapidly, disappears on pressure, to return directly the pressure is removed; but there will be no pitting of the parts to indicate œdema. In a day or two these symptoms will subside or disappear, and the cuticle will desquamate.

In the *more severe* form of cutaneous erysipelas the vascularity of the skin will be as intense as in the simple, but it may be more livid. It will, however, be associated with some perceptible thickening of the parts, the inflamed tissues feeling raised on palpation. Where much cellular tissue exists, as in the eyelids or scrotum, œdema will rapidly show itself. Small or large vesicles may likewise form on the surface, containing either a clear serum or a blood-stained or sero-purulent fluid, the latter form indicating great depression. In the head or other parts where the skin is tight the feeling of tension is very great and the surface looks shining, the features being altogether obliterated. There is rarely, however, much pain.

Course and Duration.—The disease runs its course in about ten days. During the first three or four it spreads, and, having reached its height, declines, the redness and swelling gradually subsiding and the skin desquamating. In some cases a local suppuration takes place, and this is always to be suspected when any local redness remains after the subsidence of the inflammation. In the eyelids and other parts containing loose cellular tissue such a result is common. In the cachectic subject the disease is always more œdematous than in the healthy. When it attacks a wound, the general symptoms are the same, but the local consist in arrest of secretion in the part, then ulceration, and later on, where union has existed, disunion, stumps and wounds sometimes reopening and discharging a thin ichorous fluid.

After the disease has subsided repair is usually slow, but at times it goes on healthily to complete recovery.

Prognosis.—Simple erysipelas, unless in the feeble or cachectic, is rarely a disease of much danger. In free-living subjects, and in others who have bad viscera, it is, however, a dangerous affection, lighting up latent disease that often proves fatal. When it attacks the scalp after head injuries, it is exceptional to find it followed by bad consequences.

Where the erysipelas attacks the mucous lining of the throat, fauces, or larynx, it may, from mechanical causes, threaten life.

In some cases the disease will affect different parts of the body consecutively or leave one spot to attack suddenly another. Such cases usually indicate want of power, and too often are found in those who have some organic disease of the kidney or other excretory organ.

Diffuse cellular inflammation may clinically be looked upon as a form of erysipelas, the disease attacking primarily the cellular tissue instead of the skin. It is characterized by the same diffused form of inflammation and by the same atonic character. It is, however, more frequently the result of some local injury, such as a punctured or dissection wound, than is the simple form, and it is even found in patients from whom no such history can be obtained. It is generally associated with absorbent inflammation and glandular enlargement.

The disease appears as a diffused swelling and induration of the cellular tissue of the part affected, the tissues feeling infiltrated and brawny and the skin tense from over-distension. When suppuration or sloughing of the cellular tissue has taken place, fluctuation or crepitation will be detected or the parts may feel boggy. The skin, if not previously inflamed, will now participate in the disease; it will inflame, ulcerate, or slough, to permit the escape of the pent-up pus or sloughing cellular tissue. When resolution takes place at an early period of this affection, the skin may escape uninjured; but such a result is rare.

The constitutional symptoms attending these changes in the cellular tissue are always those of great depression. The febrile symptoms will be of the typhoid type, the pulse feeble, although rapid from the first, and the disposition to sink very marked. Profuse sweating is an early and constant symptom. Delirium also is sometimes present. Visceral complications are, as a rule, the cause of death, the connection between this affection and pyæmia being very close.

Phlegmonous erysipelas is a combination of the two former. It is far more serious than the simple, and as much so as the cellular inflammation. It is characterized by a diffused inflammation of the skin and cellular tissue together, the parts having a strong disposition to suppurate and slough. It is commonly the result of some punctured wound or injury involving the skin and cellular tissue beneath, and begins locally

as a brawny infiltration of the part, the skin presenting erysipelatous redness of a dusky hue, and the boundary between the inflamed and uninflamed skin being ill-marked; outside the limit of the redness the skin feels unnaturally firm, and the cellular tissue beneath as if infiltrated. To the finger the inflamed parts feel more solid and pit on pressure. Resolution is almost unknown as a termination of the disease, one case differing from another only in the extent of the destruction of tissue with which it is accompanied.

As the disease progresses, and the cellular tissue beneath the integument becomes infiltrated with inflammatory products, the skin will be made tense and cease to pit: uniform hardness of the tissues will give place to a sense of fluctuation, as of fluid, or to a boggy, quaggy, crepitating feel of sloughing cellular tissue.

If the case be left to nature, the skin will become thin and ulcerate in parts or slough in masses, to give vent to the pent-up and sloughing tissues. Phlyctænæ will also appear over the dead portions of skin, as in other forms of gangrene; while the pus and sloughs which escape are always fœtid. In bad cases the whole cellular tissue of a limb, with large portions of integument, in this way may die, bands of skin held down by fascia being left, which during recovery will become the centres of cutification.

In the ordinary run of cases this diffused infiltration of the cellular tissue is confined by the fascia to the subcutaneous tissue, but in some instances the cellular tissue that separates the muscles becomes involved, when the case assumes a far more serious aspect; for the suppuration is then of a burrowing kind, and the sloughing is more extensive. The prospect of recovery with a useful muscle becomes also very slender, for muscles and tendons may not only slough wholly or in part, but on recovery taking place they may become so closely bound together with the other tissues that they are useless as moving organs. From this cause, after phlegmonous inflammation of the hand and forearm, a stiff and immovable extremity is often met with, and the hand becomes a kind of fin.

The constitutional symptoms associated with phlegmonous erysipelas vary considerably, and their severity depends much upon the rapidity with which the disease spreads. They are, however, in character the same as are found in other forms of the affection, though they are probably more severe. The rigors are more marked, the fever is higher, the pulse more rapid, and the tendency to fall in power always greater. Thus, in the suppurative or sloughing stage of the disease the rigors frequently recur, and cold sweats and fever intervene as in an ague. When the local affection is undergoing repair, or, at any rate, has ceased to spread, and these "false ague-fits" persist, some internal or visceral complication may be looked for; the blood becomes poisoned as in septicæmia, often to the extent of destroying life.

The pathological appearances met with in cases of death from erysipelas have been kindly drawn up for me by Dr. J. F. Goodhart after a careful analysis of the post-mortem records of the hospital. They admit of being classified as *local* and *general*, the former including all those morbid changes which occur in the primary focus and in the surrounding parts directly extending from it; the latter, the various alterations of blood or tissue found in any secondary foci or in the system at large.

The *local* changes vary according to the severity of the disease and the rapidity with which it causes death.

In the slighter forms, where it has not been the immediate cause, but has supervened as an intercurrent affection in the course of some other disease, it may often happen that no morbid appearance is visible post-mortem indicating erysipelas. Again, the skin alone may be affected either with a mere faint purple discoloration or with slight œdema, or the cuticle may be raised into bullæ or separated more or less around. In more pronounced cases, the areolar tissue beneath the skin and along the tendons and intermuscular septa has numerous minute ecchymoses and extravasations of blood in it and is often soaked with yellow serum or gelatinous matter, apparently produced by a delicate fibrinous coagulum: in the more prolonged or in severe cases the serum is replaced by healthy pus. Ecchymoses in the subcutaneous areolar tissue are very common, even in cases where death has been very rapid and no other morbid appearances are seen.

It is characteristic of the further changes that there is no tendency to the limitation of the disease around the primary focus: the pus or serum leads to the formation of no abscess sac, but spreads along the subcutaneous tissues and intermuscular septa, sometimes even making a complete dissection of some of the muscles.

There may or may not be phlebitis in the parts. Where it exists the interior of the veins affected is discolored and filled with grumous chocolate-colored fluid, while the inner surface of the vein-wall is rough from the inflammatory processes it has undergone and the adhesion of small particles of clot. Where the disease has existed some time a tube

of semi-organized clot may line the vein, and within that will be found the broken-down clot, which it is often impossible microscopically to distinguish from pus.

It is quite as common, however, to find the vessels unaffected as to find them plugged, if not more so. Pus may even run along their course, sometimes apparently in their adventitia, or more often immediately outside it, and still lead to no clotting. On microscopical examination in these cases the pus is seen to lie in smooth-walled channels which in all probability are lymphatic spaces (suppurative lymphangitis).

Affection of Glands.—The neighboring lymphatic glands—*i. e.*, those in the groin if the disease be situated in the leg, the axillary if in the arm—are usually swollen, red, and ecchymosed on section, and are frequently surrounded by the same kind of serous fluid as is found in the immediate neighborhood of the primarily diseased tissue. The tissues of all the diseased parts are said to be crowded with small vegetable organisms called "bacteria." These constitute the local changes. It may be as well to add, perhaps, when erysipelas affects the scalp, that a yellow color of the vault of the skull is often observed, and also that suppuration between the bone and dura mater and suppurative arachnitis and meningitis are not very unusual sequences. About the neck it may be followed by œdema glottidis, and occasionally by pericarditis or suppurative inflammation of the mediastinum.

The morbid appearances in the system at large are similar to those found in septicæmia from other causes—viz., ecchymoses about the pleura and pericardium, a fluid and sometimes treacly state of the blood, congested kidneys, and a softened state of the liver and spleen. So soft, indeed, is the latter organ that were it not for its capsule it would at times lose all shape. The blood has been said to contain bacteria, but I have never found such during life, though they are sometimes present when the blood is examined some hours after death. In addition to these *general* changes, separate foci of diffuse cellulitis are found—in both fore-arms and in the calf of the leg, for instance, after a primary erysipelatous state of the scrotum; and in at least two recorded cases a similar diffuse cellulitis or myocarditis has been noticed in the muscular wall of the heart. Patients with erysipelas are also liable to suppurative peritonitis and pleurisy, which, though commonly so, are not necessarily determined by the presence of a neighboring wound. A subject of hernia or ovariotomy at a time when erysipelas is rife will be likely enough to die of suppurative peritonitis; while another who has undergone an excision of the breast may die of a similar form of pleurisy without showing any external evidence of erysipelas.

A wound, however, is not necessary. For example, in a post-mortem made not long since a lady about sixty had been nursing a friend who died of some febrile affection called "low fever." Within a few days she herself became exceedingly ill, and died quickly. The inspection revealed what had only been evidenced by the faintest blush on the skin during life—viz., an early suppurative inflammation of the cellular tissue of the right axilla and pectoral region, and pus on the surface of both pleuræ; all this without any external wound whatever.

As occasional causes of death in erysipelas may also be mentioned acute lobar pneumonia and a diphtheritic sloughing of the mucous coat of parts of the bowel; while, to complete the history, it must also be said that at times when erysipelas is present in a hospital or its neighborhood not only are cases of pyæmia, with its known manifestations, such as abscesses in the viscera and pus in the joints, frequent, but patients suffering from chronic suppuration become feverish and die without, it may be, any adequate cause appearing in the viscera.

In this description of the pathological appearances found in erysipelas no attempt is made to distinguish between it and cellulitis. The morbid changes in both are the same, and it is as impossible in the deadhouse as at the bedside to separate the two.

TREATMENT.—The disease in all its forms is essentially an *atonic* one; consequently, nothing like "antiphlogistic" remedies are to be entertained, and in the simpler forms which have a tendency to run a definite course the practitioner has merely to guide his patient through the attack and to ward off whatever might prove injurious. With these objects, when the patient's powers are good and no indications of feebleness manifest themselves, a mild aperient or purge, to clear out the bowels, with bland nutritious food, such as milk and beef-tea, is probably a sufficient remedial means, the disease on the third or fourth day attaining its height, and then declining.

Should any feebleness or want of power appear at the beginning or during the course of the disease, tonics are indicated: and of these iron seems the best. The tincture of the perchloride in half-drachm doses, or more to an adult, frequently repeated, with or

without quinine or strychnia, acts at times like a charm, and doubtless often cuts short the disease. Its use was introduced to British surgeons by Dr. H. Bell of Edinburgh in 1851, although Velpeau in 1841 had previously declared its value.

In the earliest stage of the affection, when the first patch of inflammation appears on the skin or around a wound, an emetic may at times abruptly check the attack.

When food cannot be taken, stimulants must be substituted; and it is well to introduce into them, and particularly into stout, some essence of meat. The form of stimulant must depend upon circumstances, but, as a rule, that which the patient has been in the habit of taking is the best. When brandy is given, it should be mixed with milk or eggs, it being always better not to give stimulants alone. The amount must be regulated with care, for over-excitation of the system is always bad.

Hypnotics or sedatives should be used with caution, for they are not usually beneficial. Of these chloral seems less liable to disagree than opium; camphor and henbane in five-grain doses are thought well of by some, while ammonia is as highly recommended by others.

In phlegmonous and cellular erysipelas the same principles of practice are applicable. In the suppurative or sloughing stages it is necessary to give abundance of good food of all kinds, and stimulants in proportion; strong animal broths and milk are the best forms of diet.

Local Treatment.—The inflamed parts should always be kept warm and raised, air being excluded from the surface; consequently, when the head and face are implicated with simple erysipelas, the old practice of dusting the parts with flour, fuller's earth, starch, or oxide of zinc is effective. Mr. C. de Morgan used cotton-wool in addition. Warm applications, however, are in some cases the best, especially the lead lotion with opium. Cold is always injurious.

In the face and head, when the parts are tense and painful, relief is readily given by following the practice of Sir R. Dobson in puncturing the skin with a series of small punctures, oozing of blood or serum being encouraged by warm applications.

In erysipelas of other parts the application of the tincture of iodine is to be recommended. Mr. Luke thought highly of the free use of collodion applied over the part; Mr. Higginbottom, of a solution of nitrate of silver twenty grains to the drachm of water; others, of the tincture of the perchloride of iron. I have employed at times all these, and prefer the tincture of iodine to any; but none of them have any certain power of arresting the progress of the disease. Some American surgeons speak strongly in favor of the application of a solution of bromine on lint with oil-silk over the whole, and quite recently the subcutaneous injection of a solution of carbolic acid has been highly spoken of. Mr. Barwell has advocated white paint.

The local treatment of the cellulo-cutaneous forms of the disease must be conducted on the same principles as the simple, but as soon as anything like tension of the integument appears incisions should be made deep enough to allow of the escape of the effused serum from the cellular tissue beneath the skin, and long enough to relieve the tension of the whole. Some, and amongst them the late Sir W. Lawrence, recommended the incision to be free, so as to extend the whole length of the affected part. Others, among whom I claim a place, prefer a greater number of limited incisions. These limited incisions answer the same purpose as the long, and are not attended with so copious a hæmorrhage or with so great a risk to life. Even after these the bleeding is at times profuse, but it may generally be readily arrested by elevating the limb and by temporary pressure.

When suppuration and sloughing exist, the surgeon must let out matter as soon as formed; for there is little doubt that the disease is kept up by its presence. The opening into these abscesses should be free, and their cavities kept clean by careful washing out at each dressing with Condy's fluid or iodine lotion—a detail which adds materially to the comfort of the patient and the well-doing of the case. De Morgan prefers a solution of chloride of zinc fifteen grains to the ounce. Dressings with boracic acid lotion ten grains to the ounce, and gutta-percha over the wet lint, should be applied to the parts, and frequently changed. Poultices are not so good, although at times patients say they derive the most comfort from them. During the period of repair the surgeon will often have to lay open sinuses. When the sloughing has been very severe, amputation may be called for.

It has ever to be borne in mind that erysipelas is highly contagious and infectious. In hospital practice, consequently, every case, as it arises, should be separated from others in which wounds exist and transferred to a separate ward. All dressings as they

leave the ward or chamber should be burnt or disinfected, and a sponge should never be used. Plenty of fresh air ought to be admitted into the room, but no draught, and disinfectants should be freely distributed about. No medical practitioner under any circumstances should go direct from a case of erysipelas to a midwifery case or to dress a wound of any sort, accidental or surgical. If he is obliged to attend a labor when in charge of a case of erysipelas, he should allow as much time as possible to intervene before doing so, and then should attend only after having changed his clothes and carefully disinfected his hands; for there is a direct connection between erysipelas and puerperal fever.

ERYTHEMA.

Erythema finds its place here, as in its clinical features it bears some resemblance to, and has been mistaken for, the simple cutaneous erysipelas. It appears as a roseate or more vivid injection of the skin, of a local or general character, disappearing on pressure and accompanied with some slight degree of œdematous swelling.

In its *transitory* form it may be regarded as a symptom of some bowel or intestinal irritation induced by irregularity in diet or other cause. In so-called bilious subjects it is by no means uncommon, and a local patch of redness on some part of the face or other part of the body often indicates the approach of a "bilious attack." It is found, also, where organic disease of the intestines is present. In other cases it precedes an attack of smallpox, attends vaccinia, and is common in children.

Hebra gives the term "*Erythema fugax*" to all these symptomatic forms of erythema.

Erythema, as a *disease*, more commonly attacks the extremities than the trunk, and the dorsal surfaces in preference to other parts. When the efflorescence appears in small patches of papules or tubercules upon the fingers or hands, the terms *E. papulatum* and *E. tuberculatum* are respectively given.

When these patches assume the form of a red ring, the term *E. annulare* is applied to it. When a second ring forms round the first before it has passed away, or when it is represented by a small spot, the *E. iris* is formed; and where many such circles or half circles appear together and touch or coalesce and spread, the *E. circinatum* and *E. gyratum* are respectively present. Wilson mentions a case in which the *E. gyratum* covered the whole body; but all these different forms of erythema must be regarded as different stages of the same disease. Hebra says, "It will depend on the period at which the patient comes under medical observation whether the case shall be diagnosed as *E. papulatum* or *E. gyratum*." He gives one term to the whole, *E. multiforme*. As the disease subsides a slight desquamation follows, and then some small deposit of pigment. Mr. Morrant Baker[1] describes an *Erythema serpens* which follows a slight, probably poisoned abrasion and spreads in a circular manner, leaving the injured part well. It generally occurs in the hand.

Treatment.—All these forms run a definite course and have a tendency to get well, lasting from one to three or four weeks. They require for treatment little else than a well-selected diet and attention to the bowels.

Erythema occurs at times during the secondary stage of cholera.

The erythema that precedes or accompanies the progress of elephantiasis is worthy of notice.

Erythema nodosum is a more definite affection; it is found in both sexes, but more commonly in the female; it is also usually seen upon the legs, but not rarely upon the arms, as well as other parts of the body. It shows itself in raised and tender oval patches of a red color and of very variable size, some being as large as a sixpence, others as of an orange; these patches at times join. At first they are of a bright-red color, but as they die away they become of a livid hue and appear very like bruises; like them, also, they lastly assume a yellow tint. The cuticle always desquamates. When the disease is limited, there may be no constitutional disturbance, although occasionally some febrile symptoms appear; and there is usually some evidence of derangement of the digestive organs, with a foul tongue. As often as not, however, the local disease is the first symptom that attracts attention. The eruption is often symmetrical. When it appears over the tibia and the skin is very red and painful, it is often mistaken for some more serious affection, such as periostitis; but the absence of the severe constitutional disturbance which commonly attends this affection ought to prevent such an error. The history of the case is enough to distinguish it from a bruise; and the different centres of redness or congestion, from erysipelas.

[1] *St. Barthol. Hosp. Rep.*, vol. ix.

Its TREATMENT is simple. Saline purgatives, tonics, and a carefully regulated diet are, as a rule, sufficient in a general way, and the application of a lead lotion to the inflamed part, with elevation of the limbs, is generally all the local treatment that is required; but in exceptional cases warm fomentations, with or without poppy decoction, give greater comfort.

ON TRAUMATIC FEVER, SEPTICÆMIA, AND PYÆMIA.

Inflammatory fever, surgical, suppurative, or traumatic fever, septicæmia, ichoræmia, puerperal fever, and pyæmia, may all be considered as so many different names for and manifestations of one condition—viz., *blood-poisoning*.

In inflammatory and surgical fever "the returning fluids of the inflamed part, its venous blood, and its lymph are the agents of general infection" (Simon), the poisoning being "due to the introduction into the torrent of the circulation of toxic substances produced by the organism itself" (Maisonneuve), the poison being probably derived from *disintegrated tissues and generated from within the body*.

In septicæmia, ichoræmia, puerperal fever, and pyæmia the absorption of *putrid* inflammatory products or of pus or pus-forming material, or of some other poison, whether from a wounded part or not, is the undoubted cause of the disease, *the poison being taken into the body* either by the veins or by the absorbents *from without*. Traumatic or surgical fever may, however, pass into septicæmia and this into pyæmia, the first being the mildest form of blood-poisoning, the last the most severe. Surgical fever generally ends in recovery: pyæmia, after the formation of secondary abscesses, either in the viscera, joints, or connective tissue, in death.

Symptoms of Blood-Poisoning.—One and all are ushered in by very similar general symptoms, and an outline of those met with in a typical example of inflammatory fever will be found on page 65, "but practically the affection shows numberless grades and differences and complications. First, there are wide differences of degree and character; for in proportion as the local process is less acute and less extensive there is less attendant febrility, and in proportion as the local process has to invade fewer successive strata of texture the fever is of shorter course. On the one hand, it may be so slight as readily to escape notice, and may end within a few hours of its commencement; on the other hand, it may last in full force during many successive days, and may be so severe as to shake the patient's life to its foundation; and besides these differences there are varieties of result, sometimes from complicative local conditions, sometimes from peculiar susceptibilities of the patient. If the wound become the seat of some large textural disorganization, with consequent soakage of putrefying material, more marked signs of *blood pollution* may be expected to mix with or supersede those of common inflammatory fever. The patient's general state will then incline to be one of depression and apathy; his tongue will be more than commonly foul, and fœtid diarrhœa will probably exist; or if, perchance, during the local process it happen (as is especially apt to be the case where cancellous bone-structure is affected) that pus passes up a vein into the general stream of blood, the patient's improvement is abruptly cut short by the *severe recurrent rigors and sweating of pyæmia*, accompanied by local signs of secondary suppuration in parts to which the pus is conveyed" (Simon).

Confirmed blood-poisoning, therefore, is characterized not only by all the symptoms of inflammatory fever, but by *severe rigors* breaking in upon the febrile symptoms, by *sudden and marked variations of temperature* (*vide* Fig. 15), *by profuse sweats and great depression of the patient's powers*; and when these symptoms occur in the course of an attack of inflammatory fever, severe blood-poisoning is certainly indicated, the gravity of the attack being measured by the intensity of the symptoms. We generally meet, moreover, in pyæmia with local signs of inflammation of some internal organ or external part of the body; and this inflammation runs on to the formation of *metastatic or secondary abscesses*, as they are called. When an internal organ is involved in this disease, the result, as a rule, is fatal. When suppuration attacks the integuments or extremities, although it may be severe, there is always some hope of recovery. It is an interesting clinical fact that these two different forms are rarely met with in the same subject. They may for clearness be separately called *internal* and *external* pyæmia, or *acute* or *chronic* pyæmia, when involving internal parts, being generally rapid in its course and fatal, and when attacking external parts it is as a rule chronic; at times, however, the latter may supervene upon the former variety.

In many cases of pyæmia a peculiar sweet hay-like odor of the breath is undoubtedly

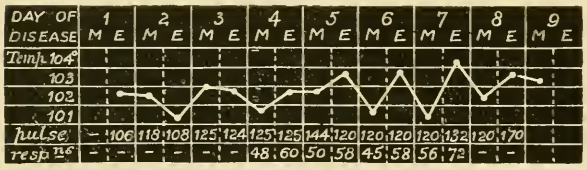
present. Some authors—and Braidwood is amongst them—look upon this symptom as pathognomonic.

Traumatic fever, when it occurs, generally makes its appearance from the second to the ninth day after an accident or operation and seldom lasts over a week. In a simple case it may subside after twenty-four hours, and in a severe one it may continue for a week. When a *relapse* or a second sudden rise of temperature takes place, grave mischief may be anticipated, as some local internal or external inflammation. Billroth has described this second attack of fever as "secondary fever." When it runs on for a more lengthened period than a week, severe complications are sure to exist to keep up the symptoms. During its course the temperature of the body, naturally 98.6° F., may rise suddenly 5° or 6° F., and in ordinary cases its fall is, as a rule, gradual; while with its fall defervescence takes place. Should the fall be sudden, a general breakdown of the powers of the patient is indicated; and under these circumstances sloughing of the wound may be expected. The rise of temperature is generally accompanied by an arrest of secretion or some change of action in the wound, but the fall of temperature indicates the oncoming of suppuration.

These points are well seen in the following thermographs, figs. 15, 16, 17, 18, and 19.

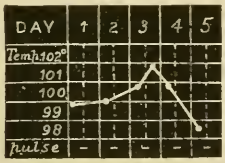
It is, however, important to know that traumatic fever is by no means a necessary consequence of an injury or operation, however severe, that it may follow a trivial or fail to follow a severe injury, and that it is quite impossible to predict its occurrence under any circumstances. After a large number of capital operations it is entirely absent—I should say after one-third; and since the practice of the torsion of arteries has been adopted, and wounds have consequently been freed from the presence of such foreign bodies as ligatures, the number of cases in which it is absent has decidedly increased.

Fig. 15.



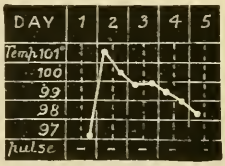
Thermograph of acute ostitis of the tibia in a boy, æt. 16, following a blow; admitted into Guy's on the fourteenth day with pyæmia, which destroyed life nine days later. The table well shows the fluctuation of temperature which is found in pyæmia, with the night and morning variations.

Fig. 16.



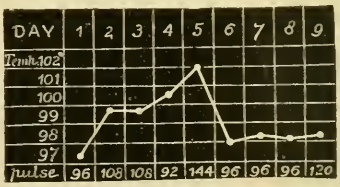
Thermograph of traumatic fever, rise for three days, sudden fall, after amputation at hip-joint, in a boy, æt. 9, terminating in recovery.

Fig. 17.



Thermograph of traumatic fever, sudden rise and steady fall after amputation of the leg for disease of foot in man, æt. 52, terminating in recovery.

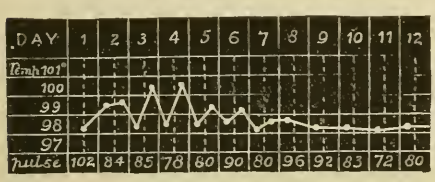
Fig. 18.



Thermograph of traumatic fever after operation for ruptured perinæum. Fever at its height on fifth day, when quill sutures were removed, after which there was a sudden fall and a steady convalescence. Patient æt. 45.

Arrest of Secretion.—When blood-poisoning attacks a patient the subject of a wound, whether caused by operation or injury, it is generally to be observed that the secretion of the wound becomes sanious, serous, or fœtid; probably it will be arrested, and the surface will become glazed or glassy, or perchance assume a sloughing action. The integument around the wound will often have an erythematous blush, or acquire a peculiar leaden, dusky appearance, which is somewhat typical. Union, if progressing, will cease, or disunion may result. When any internal organ is implicated, special symptoms indicative of disturbance of its functions will be present. When the *brain* is involved, there will be sleeplessness or delirium of a low muttering kind or "*relapsing unconsciousness*"—

Fig. 19.



Thermograph of traumatic fever after ovariotomy in a woman, æt. 43, ending in recovery. Temperature never rose above 100.

unconsciousness from which the patient can be roused only to relapse. In rare cases acute delirium and mania occur.

When the *respiratory organs* are involved—and it may be stated that they are so far more frequently than any other—difficulty of breathing, with a harsh dry cough, and perhaps viscid blood-stained sputum, are the prominent symptoms; occasionally pleuritic pains are present, or symptoms of bronchitis, with great dyspnœa.

When the *abdominal viscera* are affected, nausea or sickness and profuse diarrhœa are prominent symptoms; the latter in some cases apparently carries off the poison. When anything like sallowness of the skin or jaundice appears, hepatic abscess should be suspected; and under these circumstances there will often be pain in the region of the liver. At the same time, the reader must remember that a slight degree of jaundice is often present without hepatic suppuration. The urine is rarely altered either in character or in quantity, although at times it is scanty and dark-colored. When severe or dull pains are experienced in a joint, suppuration should be suspected; and anything like so-called rheumatic pains occurring in a patient with pyæmia becomes a source of suspicion: "rheumatic" pains in blood-poisoning too often mean joint or bone mischief of a suppurative kind. It is also remarkable how slight the symptoms often are in these cases when severe local disease exists. This fact demands that the surgeon should ever be on the watch to detect anything like local changes, inasmuch as it is a pathological truth that there is no organ or tissue of the body in which suppurative disease may not take place in a case of blood-poisoning or pyæmia; and it is certainly true that the existence of severe local disease is too often only first discovered on the *post-mortem* table.

What, then, it may be asked, are the *pathological conditions found after death* in a case of blood-poisoning or pyæmia, using this word in a general sense?

Analysis of 203 Fatal Cases of Pyæmia.

Nature of Accident or Disease.	Number of cases.	Lungs.		Liver.		Kidneys.		Spleen.		Brain.		Heart.		Joints.		Cell-tissue.	
		Cases.	Alone.[1]	Cases.	Per cent.	Cases.	Per cent.	Cases.	Per cent.	Cases.	Per cent.	Cases.	Per cent.	Cases.	Per cent.	Cases.	Per cent.
Compound fracture	26	23	$11_{42\cdot3}$	9	34.6	3	11.5	1	3.8	...	.....	...	.....	4	15.3	3	11.5
Amputation after compound fracture	38	34	$14_{36\cdot9}$	15	39.4	2	5.2	6	15.7	...	.....	...	.....	4	10.5	3	7.8
Amputation for disease	29	24	$14_{48\cdot2}$	6	20.6	2	6.9	2	6.9	2	6.9	...	.....	2	6.9	4	13.8
Injury to scalp and skull	11	11	$1_{9\cdot}$	7	63.6	...	.....	...	.....	5	45.4	...	.....	1	9.	2	18.1
Inflammation and suppuration of soft parts	33	30	$9_{27\cdot}$	8	24.2	8	24.2	5	15.1	2	6.	5	15.1	8	24.2	5	15.1
Disease of urinary organs	22	22	$11_{50\cdot}$	...	.....	10	45.4	...	.....	1	4.5	1	4.5	...	.....	1	4.5
Disease of bones and joints	28	27	$9_{32\cdot}$	6	21.4	8	28.5	4	14.2	...	.....	4	14.2	6	21.4	2	7.1
Operations on soft parts	5	5	$2_{40\cdot}$	1	20.	1	20.	1	20.	...	.....	1	20.	...	.....	1	20.
Carbuncle	6	5	$2_{33\cdot}$	3	50.	2	33.3	...	.....	1	16.6	2	33.3				
Burns	5	5	$5_{100\cdot}$														
TOTAL	203	186 or 91.6 per cent.	78 or 38.4 per cent.	52[2]	27.	36	17.7	19	9.3	11	5.4	13	6.4	25[3]	12.3	21	10.3

[1] In which the lungs were alone involved. The small figures show the percentages. [2] The liver was involved alone in two cases only; in all others the lungs were affected as well. [3] Sterno-clavicular in eight.

The analysis (shown in the form of a table, above) of two hundred and three fatal cases, which I have collected from the records of Guy's Hospital with the sanction of my colleagues, Drs. Wilks and Moxon, by whom all the examinations were made, will answer this question.

Pathological Conditions from Pyæmia found after Death.

The Lungs.—The most prominent fact indicated by this table has reference to the lungs, for it proves that in the larger proportion of fatal cases of blood-poisoning these organs are implicated, and, further, that in many they are the only parts involved. Lung mischief was found one hundred and eighty-seven times in two hundred and three cases; while in seventy-eight cases, or thirty-eight in every hundred, the lungs were the only organs affected. *Lobular pneumonia* is the form in which the disease is generally found; and when even a lobar pneumonia is present, it can usually be made out to have originated in lobules and to have spread from them as centres. This lobular pneumonia, like the lobar form, is also generally seen in the *lower lobes*, and not at the apices, and nearer the surface than the central parts. The earliest indication of disease is a lobular pneumonia, and "subsequently," says Wilks, "these congested spots are found to contain

inflammatory products; and thus we have red hepatization, suppuration, or sloughing," all these stages of inflammation being visible in individual masses. Associated with this lobular pneumonia some *ecchymosis* of the surface of the lung will generally be found—a purpuric condition, in fact—strongly suggestive of blood-poisoning. Pleurisy, moreover, generally exists, the fact being accounted for by the superficial position of the lobular pneumonia.

The Liver, like the lungs, is also attacked in its lobules, which may be either congested, inflamed, suppurating, or sloughing. At times it is filled with small abscesses. When these approach the surface of the liver, they may burst and give rise to a general peritonitis. The liver was involved in this affection twenty-seven times in every hundred cases, and almost always in association with disease in the lungs. Thus, out of fifty-five case in which the liver was affected, in only two were the lungs uninvolved. It would appear, likewise, from the table that the liver is more frequently the seat of pyæmic suppuration after injuries to the head than after any other affection, and that it is rarely found involved after disease of the urinary organs and burns.

The Kidneys.—When these organs are affected, they are so in a similar manner to the lungs and liver, and present small isolated points of suppuration surrounded by a zone of congestion either on their surface or in their cortical structure. They are not, however, affected so frequently as are the two former organs—not oftener, indeed, than in seventeen cases out of every hundred, and then mostly after disease of the urinary organs, or suppurative disease of the cellular tissue, particularly of that surrounding the shafts of bones.

In the Spleen abscesses are often present, and in the Brain, Heart, Prostate, Testis, Tongue, Thyroid Gland, and, in fact, in any portion of the body, they may be met with. In the cellular tissue of the trunk and extremities, as the joints, suppuration is very common.

When inflammation attacks such serous membranes as the pleura and peritoneum, there is good reason to believe that it is generally due to the extension of disease from the lung, liver, or spleen. In the case of the synovial membrane of the joints no such extension can be made out. The sterno-clavicular articulation is more frequently involved than any other, for I find that out of twenty-five instances in which joint complication existed this was involved in eight. Any joint may, however, be affected. In some cases the articulation is only filled with an increase of synovia; in others the contents are puriform, sometimes purulent. At times the pus in the joint appears to be so slightly irritating that the cartilage and the synovial membrane are uninjured by its presence, whilst at others it is so destructive as to produce complete disorganization, the bones forming the joint being under these circumstances exposed, and at times necrotic. When these changes occur, they are probably sometimes due to acute articular ostitis.

The skin has occasionally a *vesicular* or *pustular eruption* upon it, and too frequently *purpuric spots* or patches are present, which at times lead on to mortification; and in connection with this subject "we may mention another evidence of the blood disease in the rapid decomposition of the bodies and the marking of the veins on the surface. Thus, before the body is scarcely cold there may sometimes be seen the blue and red coursing of the veins and the coloring which has exuded from them into the tissues" (Wilks).

Lastly, it is to be noted that it is exceptional to meet with any evidence of *phlebitis*, general or local; and this leads me to consider, although briefly, the now already abandoned and untenable theory that phlebitis, or inflammation of a vein, is the invariable cause of pyæmia.

The most telling evidence against the theory is the one just mentioned—that it is only in exceptional cases of pyæmia that any evidence can be found of phlebitis; and the second is almost equally strong, because, "so far from phlebitis being a cause of pyæmia, it is remarkable how often the former occurs without any contamination of the blood whatever—that is, if we can call that phlebitis where we find a vein and its branches quite closed by coagulum or adherent fibrin" (Wilks). Moreover, "it is a question whether, in those cases in which the veins are plugged or inflamed, thrombosis and phlebitis are not the local and pyæmia the general effect of the same cause" (Savory)—that is, blood infection. With these views I cordially agree.

That blood-poisoning may take place through veins is certain, although, as I have already shown, inflammation of their coats does not necessarily lead to it; neither is it probable that the absorption of pus, as pus, is the usual cause, for, when pus mixes with blood coagulation is produced, and thus its circulation is prevented. There seems, however, good reason to believe that the fluid portion of pus or of some decomposing inflam-

matory product may be taken up by the veins and carried into the system, and thus cause pyæmia. The poison may be imported into the general circulation through either a small or large vein when involved in a suppurating or sloughing tissue; this is a frequent occurrence when the vein is connected with an inflamed or divided bone.

Theory of Pyæmia.—It may be fairly inferred that the *milder forms of blood-poisoning*, such as traumatic fever, are caused by the circulation of morbid elements in the blood, which are generated either within the body or imported into it from without, and that these morbid elements are at times carried off, sometimes by the lungs and at other times by the intestines; that the *more severe forms of blood-poisoning*, as pyæmia, are caused by embolism, thrombosis, or blood extravasation, due to the admixture with the blood of some morbid fluid; and that this morbid material originates the changes which give rise to the secondary or metastatic abscesses with which surgeons and pathologists are so familiar. This view receives much support from the fact that disintegrating fibrin may be carried from the heart through the arterial system into the smaller vessels of the parenchymatous organs, and give rise not only to constitutional symptoms much akin to those which have been described as being present in pyæmia, but to analogous pathological conditions. This condition is spoken of as arterial pyæmia. Thus, in the more common form of pyæmia abscesses form in the viscera or in other parts, and in "arterial pyæmia" lobular fibrinous changes occur. In the former case secondary abscesses are found after death; in the latter, secondary fibrinous deposits. It seems probable, also, that at times these fibrinous deposits may break down and give rise to abscesses.

This arterial pyæmia is met with after ulcerative and rheumatic endocarditis; it is, doubtless, the cause of the so-called rheumatic pains that follow scarlet fever, and in rarer instances it gives rise to the embolic plugging of some large vessel, which may be followed by gangrene or by the formation of an aneurism. On two occasions I have had to remove a leg for gangrene from embolism of the femoral artery after scarlet fever. I have also seen cases of aneurism which have probably been due to the same cause.[1]

Arterial pyæmia is not necessarily fatal. Mild attacks come and go, says Wilks, "the proof being found eventually in the cicatrices and remnants of deposits met with in the organs of the bodies of those who have died with heart disease." The mild forms manifest themselves by pyrexia, prostration, and pains in the joints.

Hence, when a patient dies rapidly from blood-poisoning, the only pathological change found in the tissues may be some lobular congestion of the lung, indicating the first stage of pneumonia; when life has lasted longer red or gray hepatization may be present, and in a later stage suppuration, these different conditions depending upon the intensity of the disease and its duration. "The first stage of the morbid condition which is produced in the viscera is a coagulation in the vessels, and the last stage is a suppuration" (Wilks).

In feeble patients who have no resisting power against disease it is possible that even these pathological conditions may not be found, life being, as it were, suddenly destroyed in the first onset of the blood-poisoning. Under these circumstances no definite post-mortem appearances would be seen, beyond, perhaps, a general softening of the viscera or some purpuric condition.

Duration of the Disease.—There seems reason to believe that a patient may die in two or three days after the first appearance of the symptoms, and, as a rule, bad cases terminate during the second week. Others go on for six or seven weeks. The longer a patient lives, the greater the hopes of a successful issue.

Prognosis.—In every case of blood-poisoning great cause for anxiety exists, it being impossible to foretell its course or its end. In one case a small dose of the poison will prove fatal, while in another a full dose will be thrown off. The violence of the attack does not depend upon the severity or size of the wound, for a trifling wound is at times followed by urgent symptoms, while a severe local injury may be followed by but few, if any, complications. Indeed, some of the severest cases of blood-poisoning are found in those in whom there is no wound.

A robust person, doubtless, has a better chance of recovery than a feeble, and an abstemious one than a drunkard. Where diseased viscera exist, particularly diseased kidneys, the prospects of recovery are small indeed, the capabilities of a patient to resist any diseased action under these circumstances being slight in the extreme. A single attack of traumatic fever may pass off without trouble, but a relapse or a second attack always indicates serious mischief. Rigors rarely occur without suggesting the presence of some secondary deposit or local inflammation. One rigor may pass off and leave no

[1] Vide *Path. Soc. Trans.*, 1877.

trace of harm behind, but a succession of them is associated too frequently with the gravest local complications, such as secondary metastatic abscesses. These abscesses, also, when they occur outside any of the three great cavities of the body, are less dangerous than when they occur in the viscera. Acute pyæmia is always accompanied with great danger; when the disease is chronic, there is always more hope.

The occurrence of pyæmia in different surgical affections is well shown in the following analysis of cases:

Of 217 consecutive cases of pyæmia, 68, or 31.3 per cent., were after compound fractures, of which 24, or 11 per. cent., were not amputated, and 44, or 20.2 per cent., were amputated: 26, or 12 per cent., were after amputation for disease; 28, or 12.9 per cent., were after other operations; 21, or 9.6 per cent., were after injury of soft parts without operation; 60, or 27.6 per cent., were after disease without operation; 12, or 5.5 per cent., were idiopathic; 2.9 per cent., puerperal.

Statistics of Compound Fracture.

Out of 790 cases, 192 died, or 24 per cent.: 68, or 8.6 per cent., of pyæmia.

Of 184 cases treated by amputation, 89 died, or 47.7 per cent.; 44, or 23.9 per cent., of pyæmia.

Of 606 treated without amputation, 103 died; or 17 per cent.; 24, or 3.9 per cent., of pyæmia.

Out of 324 cases of amputation of thigh, leg, arm, and fore-arm for disease, 126 died, or 38.8 per cent.: 26, or 8 per cent., of pyæmia.

Pyæmia is thus seen to be three times as fatal after amputation for compound fracture as for disease.

Out of 29,434 surgical cases admitted into Guy's during ten years, there were 1749 deaths, or 5.9 per cent.; 203 of these, or 11.6 per cent. of the fatal cases, were from pyæmia, about 1 in 9 of the deaths arising from this cause.

But of the whole number of cases treated, pyæmia was fatal in 1 case out of 145.

Statistics of last Five Years, ending with 1882.

During these years a better result than the above can be recorded; and out of 14,951 surgical cases, of which 847 cases, or 5.6 per cent., died, only 42, or 5 per cent. of the fatal cases, died from pyæmia, the general mortality of pyæmia in the last five years having fallen from 1 in every 145 cases treated to 1 in every 356.

In the *compound fractures*, also, a like improvement is indicated by the fact that of the 213 cases treated 32, or 15 per cent., died, and only 4 of these from pyæmia.

Of 120 cases treated conservatively, 9 cases, or 7.5 per cent., died, 1 from pyæmia.

Of 93 cases treated by amputation, 23 cases, or 24.7 per cent., died, 3 from pyæmia.

Out of 11 double amputations, 5 recovered.

But is pyæmia a hospital disease? Does it arise from causes that are generated in a hospital, or is it met with more frequently in a hospital because the class of cases in which it is most prone to occur are there treated? Is it found in private practice?

As an answer to the last question it is only necessary for me to refer to Mr. Prescott Hewett's presidential address at the Clinical Society in 1874, in which he gave the particulars of twenty-three examples of pyæmia occurring in private practice and in six only after operations, four of which were very trivial.

Sixteen of these were in town and seven in the country, and all were placed under most favorable circumstances.

We know, moreover, that some of the worst cases of pyæmia that are seen in the London hospitals—and I can answer for Guy's—are admitted with the infection.

Under these circumstances it may confidently be asserted that what is known as pyæmia is not peculiarly a hospital disease, and that it probably occurs after surgical injuries and operations as frequently in private as in hospital practice. It is true that pyæmia often takes its origin in hospitals, but equally true is it that it does so because the class of cases in which the affection is the most prone to occur are there to be found.

Blood-poisoning may occur anywhere, in hospitals or in private houses; but it is unfair and unscientific to attribute it without reason or evidence to what has been so wrongfully described as "hospitalism."

Treatment.—An unlimited supply of fresh air, simple nutritious food, and where a wound or suppuration exists the most thorough *cleanliness*, are the main points of prac-

tice to be attended to in the treatment of every case of traumatic fever or pyæmia. Compared with these, all other means are of secondary importance.

As the disease is due to a blood-poison often taken into the body from without, it is the surgeon's duty to see that the patient's room is well ventilated, that it is neither too hot nor too cold—as both extremes are powerful depressants—that the air circulating through it is free, fresh, and fragrant, that the room is frequently purified by cleansing and disinfectants, large dishes of any disinfecting fluid and cloths saturated with the same being distributed about; solid iodine exposed in a plate to the air is a good disinfectant, and more persistent than some others. Care must be taken that no poison from a drain or closet reaches the room, and that all excretions are disinfected at once—indeed, passed directly into vessels containing disinfecting fluid, such as Condy's, carbolic acid, chloride of lime, or chloralum. The wound should be kept *clean*, and care should be taken that all discharges are allowed a free escape. Dressings, when employed to a suppurating or sloughing wound, should be saturated with disinfecting lotions and changed every three or four hours. When possible, foul wounds should be irrigated, a stream of warm water containing a disinfectant being allowed to run over the surface. I know of no means so valuable for keeping a wound clean as this. When sloughing of the part is present, charcoal poultices are at times beneficial. Sponges should never be employed where pus exists, but tow or cotton-wool, more particularly the absorbing cotton-wool. Poultices, when employed, may be put on tow or oakum, both of which materials, through the tar they contain, being disinfectants.

In simple *uncomplicated traumatic fever*, when it stops within the ordinary bounds and neither runs on nor returns in any severity, no special treatment is called for. Should restlessness or much pain exist, a sedative dose of chloral, opium, or morphia may be given, either by the mouth, rectum, or skin; and beyond this nothing is needed. In more confirmed cases of suppurative fever, when systemic infection is declared, the vital energies of the patient must be maintained or stimulated, and everything that tends to lower must be warded off; thus, the administration of tonic medicine becomes a necessity, the preparations of quinine being the best, but strychnine and iron are likewise of great use. From ten to twenty grains of quinine given at the first onset of pyæmia and repeated every three or four hours help defervescence.[1] Stimulants must be administered with caution and their amount regulated by the wants of the individual case. When the patient's habits have been free, alcohol in one of its forms will be required, even in large quantities; whereas to an abstemious person a very moderate dose will be sufficient. The form of stimulant to which the patient has been accustomed is apparently the best.

The diet should be as nutritious as possible, but its nature must depend upon the assimilative powers of the stomach. Where milk agrees no better drink can be given, either alone or mixed with eggs or some spirit; cream may be added at times, or the concentrated Swiss milk; animal broths may likewise be freely used. When meat can be digested, it may be given, although sparingly. When a patient refuses food, Liebig's extract of meat or Darby's fluid meat may be mixed with the beer or wine without his knowledge. When the stomach rejects nourishment, it must be given by the rectum, a two- or three-ounce enema of beef-tea and egg being administered every four or six hours. Ice may always be allowed in small quantities, as it gives comfort. When the nervous system is disturbed from want of sleep or otherwise, opium may be given, small doses frequently repeated being better than large. Where enemata are used, laudanum may be mixed with them.

Should diarrhœa exist, it must not be checked too suddenly, for in some cases of blood-poisoning it appears to have an eliminative tendency; it should be stopped only when telling on the patient's powers. To give remedies, however, with the view of eliminating the poison by the bowel is a rash practice and cannot be recommended. The sulphites and chlorides, which have been highly praised, do not appear, in any of their forms, to have any power to neutralize the poison in the blood. The alkaline salts have likewise been strongly recommended "to promote the changing and eliminating of the products of the retrograde metamorphosis of the tissues" (Savory), of which the carbonate of ammonia is probably the best, either given alone or with the liquid extract of bark.

When secondary abscesses have formed in the cellular tissue and between the muscles, they should be opened; but great caution must be observed in dealing with inflamed joints. When the presence of pus can be clearly made out, it should be evacuated by a free incision into the joint and care taken that it does not reaccumulate; to prevent this, a drainage-tube should be introduced into the cavity and the joint daily freely washed

[1] Goodheart, *Guy's Hosp. Rep.*, 1870.

out with a stream of warm water colored with Condy's or some other disinfecting fluid, such as carbolic acid one part in forty, or iodine water composed of one drachm of the tincture of iodine to a pint of water. Soothing applications should at the same time be employed, poppy fomentations being probably the best.

When acute blood-poisoning has set in, it is almost needless to say that amputation of a diseased limb has nó influence in checking the disease, nor has the application of caustics or cauteries to a wound; indeed, no local treatment is known by which the formation of secondary abscesses can be prevented. In chronic pyæmia, however, amputation is often of essential service.

How far blood-poisoning can be prevented is another question, and, as it is an important one, it may be considered here.

As to the exciting cause of the disease nothing is known. It attacks the healthy as well as the cachectic, those surrounded by perfect hygienic influences as well as those subjected to the most unfavorable, and it is found in private as well as in public practice. It is true that the cachectic and those who are subjected to close and unhealthy atmospheres are the more prone to its attack, and that overcrowding in small wards, bad ventilation, bad drainage, and bad feeding, with every other depressing influence, have an injurious tendency. It becomes the surgeon's duty, therefore, to ward off, as far as he can, all such influences. In cases for operation, when time is allowed for preparation, the general condition of the patient should be investigated; care should be taken that the excretory glands are performing their functions, and if not they should, if possible, be at once corrected. The feeble must be strengthened by tonics and good nutritious food, and the supply of stimulants should be regulated in all. The intemperate man should be brought to see the necessity for moderation, and to know that life cannot long be sustained by drink alone; he must learn, also, that stimulants are chiefly of value in assisting digestion and the assimilation of nutritious food. *The urine under all circumstances should be examined for albumen;* for, although its presence would not deter the surgeon from performing an operation of necessity to save life, it would affect his prognosis, and would most certainly influence his decision in an operation of expediency. All patients after operation should be kept in absolute repose, the wounds kept clean and lightly dressed. Everything that tends to procure rapid union must be considered good, and all that induces or keeps up suppuration bad. Blood-poisoning and suppuration, whether with or without a wound, have a close connection. No one who has been in contact with any infectious disorder, such as erysipelas or scarlet fever, should be allowed to come near the patient; for there can be no doubt that there is subtle connection between these poisons and pyæmia. And, lastly, every cheering influence should be brought to bear on the mind of the patient, as well as on his surroundings; for among the agents predisposing to blood-poisoning mental anxieties and depressing emotions should doubtless be reckoned.

HECTIC FEVER.

There can be little doubt that surgeons of former times included under the above heading many cases of what we now call septicæmia, pyæmia, or blood-poisoning; and even at the present time it is an open point as to how far the symptoms which denote hectic fever are due to the absorption of some foreign element into the blood.

That hectic fever is never found except in those who are the victims of destructive organic changes, chiefly of a suppurative nature, is an established fact, and it is in such, also, that confirmed blood-poisoning generally occurs. The physician meets with this condition in pneumonia, phthisis, empyema, abscess in the liver, kidneys, or ovary; the surgeon, in suppurative diseases of joints and bones, in spinal disease, compound fractures, diffused suppurations, etc. The characteristic symptoms are of a remittent character and usually appear at least once daily, generally toward evening, but they may occur more frequently. They are not unlike those of ague.

A paroxysm of hectic may be said to commence with fever, of more or less intensity; the skin will be hot and dry, the pulse rapid and feeble. The face, too, will be flushed in a single patch, and the palms of the hands and the soles of the feet hot and burning. The tongue during the paroxysm may be dry and great thirst will be present. There will, however, be no brain symptoms, no clouding of the intellect, no delirium. The febrile condition may be preceded by shivering or chilliness, but such symptoms are unusual and are always followed by *a profuse and exhaustive sweat.* This sweating is, indeed, peculiar to the affection; for it bears no proportion to the febrile symptoms that preceded it. At the commencement of the disease the febrility may be so slight as hardly to be noticed,

and yet the patient, on falling to sleep and awakening, will be bathed in perspiration. When the disease is at its height, the cold, hot, and sweating stages may be easily seen; but when it declines, the febrile symptoms will be constant, although aggravated toward night, while the morning "colliquative" sweats gradually become more profuse as life ebbs away.

In the early stages of this disease, *between* the paroxysms, there may be no fever. The tongue, dry during the attack, will be moist and clean, but toward the close becomes morbidly red, smooth, and sore, with aphthous ulceration. The appetite and digestive organs are rarely much affected; indeed, they are little altered till the general powers are failing rapidly. The skin, at first supple and moist between the attacks, becomes, as the disease progresses, harsh, dry, and covered with branny scales. The urine, always scanty and high-colored, is more so toward the close of the disease. The bowels are sometimes constipated, but more frequently loose. Throughout the disease, however, the mental faculties remain unimpaired, even when the bodily powers are reduced to a minimum. During the whole disease sleep is usually obtained between the attacks. Death always ensues from exhaustion, which bed-sores too frequently aggravate.

Treatment.—The removal of the cause of the disease is the only means by which a cure can be effected. As the affection is one purely of exhaustion, the object must be to maintain the strength of the patient in every way by the administration of abundance of simple nutritious food, with stimulants carefully adjusted to the special wants of the case. The former should be given at certain short intervals in small quantities, and the latter in sufficient quantities to aid digestion.

Tonic medicine should always be given, quinine probably being the best, as this drug has, doubtless, a power in checking febrile action, in keeping down the temperature of the body, and in preventing sweats. It should be given in a full dose, five grains in the solid form, before the paroxysm. Iron and strychnine are also valuable drugs, and the extract of belladonna in doses of half a grain or more combined with the tonic is of great value. Diarrhœa, when present, should be checked by astringents, but opium should be sparingly employed, except to relieve pain.

With respect to the removal of the cause of the disease by operation when such is possible there can be no difference of opinion among surgeons, for hectic is a proof that nature's reparative powers have been found wanting in their efforts to cure the local affection; and under these circumstances the surgeon's duty doubtless lies in operative interference. If the disease can be removed, this should be done, and delay is almost criminal. Let the source of irritation or weakness be removed, and it is wonderful how rapidly the most feeble subject may rally after the operation. If the viscera are sound, good hopes of a recovery may be entertained under apparently the most adverse conditions; but if the kidneys are diseased, the prospects of recovery are feeble.

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CHAPTER II.

ON ANIMAL POISONS.

POISONED WOUNDS.

Dissection Wounds.—These are of frequent occurrence, although it is exceptional to find them followed by any seriously ill effects. In common with all wounds, they may be attended with absorbent inflammation, inflammation of the cellular tissue, suppuration, septicæmia, or pyæmia; and feeble or cachectic subjects are more liable to these consequences than the strong and steady. In exceptional instances, however, different results follow, and two forms of the affection may be recognized—the *mild* and the *acute*.

"The symptoms in the '*mild*' form partake," says Poland, "more or less of the ordinary character of non-specific inflammation and scarcely present any noticeable characteristic signs. Thus, the local appearances consist in the puncture assuming a defined red aspect, which soon becomes pustular; this bursts, and ends in an unhealthy suppuration; there is surrounding erythema of an erratic form and inflammation and pain extending along the fore-arm and arm to the axilla, ending in the enlargement and suppuration of the glands. The constitutional effects consist in febrile disturbance, loss of appetite, diarrhœa, fetid eructations, etc. The prognosis and termination are favorable, and the treatment required is to be based upon general principles."

The symptoms of the "*acute*" or severe forms are those of a truly specific disease; the local signs commence by the appearance of a small circular or oval vesicle over the seat of puncture, which soon becomes turbid, milky, and pustular and not unfrequently has a defined margin resembling somewhat that of smallpox. This is generally unattended with pain, but the patient often complains of intense pain in the shoulder and about the axilla, which shoots down the chest. The glands in the axilla are early affected and seem to act as barriers to the further progress of the poison; they become enlarged and the surrounding cellular tissue is implicated, with serous effusion; there is erythema and puffy swelling; these extend to the subscapular and pectoral regions, spreading down the side of the chest, yielding to pressure, and imparting a peculiar spongy feel. There is, besides, an œdematous and doughy condition of the arm and fore-arm, owing to serous exudation into the cellular tissue, which seldom, if ever, passes into suppuration."

"The constitutional symptoms are at first those of strong excitement, but these are soon followed by those of extreme depression of spirits and much suffering. Rigors, headache, prostration of strength, vomiting, etc., supervene; and, lastly, all the symptoms of low typhoid fever rapidly set in."

In some cases the absorbent glands are not involved, and death may occur from prostration in the early stage of the disease; in others, suppuration and pyæmia may appear; while in a third, extensive and diffused sloughing of the skin may ensue; all these points being materially influenced by the power of the patient to throw off morbific influences.

The PROGNOSIS in these acute cases must be unfavorable. Travers calculated that one in seven recovers: probably this is rather in excess of experience; but if the patient does not sink during the violence of the attack, his powers will be tried to the utmost by the protracted suppuration.

The inoculation from a recently-dead body is more serious than that from an old subject of the dissecting-room, and bodies that have been preserved by chloride of zinc are less noxious than others. The fluids from a patient who has died from glanders, peritonitis, and scarlet or puerperal fever are far more dangerous than all others. Indeed, there is reason to believe that the contact with such fluids is capable of giving rise to the disease without any local wound or abrasion.

TREATMENT.—To keep the patient alive and to treat local symptoms as they arise on general principles are the usual methods now pursued.

A student when he pricks his finger should at once clean and suck the wound, arresting at the same time the circulation of blood through it for at least a minute by pressure applied with the opposite hand on its cardiac side. The part may then be closed over, a piece of gutta-percha skin made adherent with chloroform being an admirable application. When the wound is free and the poison is from a recent puerperal case, some caustic,

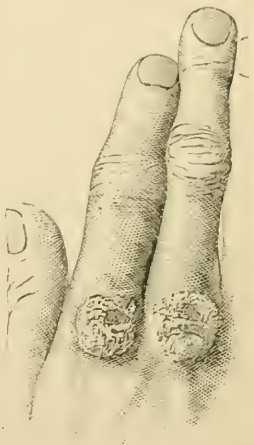
such as the nitrate of silver, chloride of zinc, or even nitric acid, may be applied. The first two are probably the best. When any inflammation appears, a poultice should be applied and the hand raised above the shoulder; and if there should be any tension of the part, it is to be at once relieved by an incision.

Absorbent or cellular inflammation should be treated by fomentations or the application of the extract of belladonna rubbed down with glycerin to the inflamed part. Some surgeons have faith in the local application of nitrate of silver, iodine, or the solution of the perchloride of iron as a means of arresting its progress. The glands, when enlarged, should be freely bathed with hot water and hot fomentations constantly applied. The earliest indications of suppuration ought to be looked for, in order that pus may be at once evacuated. Sloughs are to be removed by moderate incisions. Tonics should be given from the first—iron when it can be borne with or without quinine in full doses, ammonia and bark when quinine and iron are inapplicable. Nutritious food ought to be given in abundance, milk being the best drink; stimulants, too, when needed, but always with caution. Country air, as soon as it can be enjoyed, is the great aid upon which reliance may be placed for recovery.

Anatomical or Pathological Tubercle.

This is a chronic skin affection which is to be met with on the hands of those constantly engaged in making post-mortem examinations. Dr. Wilks,[1] when describing some models of the affection that are to be seen in Guy's museum (Fig. 20), called it "*verruca necrogenica*." In its earlier stages it is not unlike epithelial cancer. "It commences without any evident breach of surface, the parts affected being not those liable to pustules, as the back of the hand or wrist, but the knuckles and joints of the fingers. If the disease should begin with a pustule, the pustule bursts, but instead of healing a thickening of the cuticle takes place around it; and as from time to time a little fresh suppuration occurs, so the thickening and induration increase. Generally, however, these changes go on slowly without any preliminary vesication. A warty thickening of the epithelium takes place, which in course of time becomes of a dark color, until a kind of ichthyotic condition is produced."

Fig. 20.



Anatomical Tubercle.
(Model Guy's Mus. 1935⁰.)

The disease is local and unattended by constitutional symptoms. The repeated application of the strong tincture of iodine, acid nitrate of mercury, nitric acid, or, what is better, the benzoline-gas cautery, will effect a cure.

Insect-stings in England are not very severe, and unless inflicted in large numbers are rarely brought under the notice of the surgeon. Slight fever and constitutional disturbance may follow them in children who are susceptible to external influences, whilst local swelling, heat, and redness are very marked in others. Should a wasp or bee accidentally be taken into the mouth with fruit, and the base of the tongue, pharynx, or larynx stung, serious symptoms may arise from œdema and swelling of the parts impeding respiration. When this accident happens, scarifications should be employed with fomentation; but if life be threatened, the windpipe must be opened.

When the tongue or other accessible part is affected, the sting should be removed, if possible, with a pair of fine forceps, and thus much pain is saved. Where this cannot be done a drop of either liquor ammoniæ, sal volatile, or oil of lavender applied to the part generally gives relief. The parts should also be protected from the air by collodion, flour, chalk, or strapping.

For mosquito-bites Dr. J. Stevenson of Ceylon advises (*Edin. Month. Journ.*, February, 1882) the use of a moist cake of soap, the thin lather from the cake being allowed to dry upon the bitten part. All pain and itching, he states, disappears within ten minutes of this application.

The bite of the scorpion, the tarantula, and other tropical insects is, however, more troublesome, and is often followed by nervous depression, vomiting, and local pain. In South America the mosquito-bite is at times attended with severe local inflammation, and sometimes with ulceration. In Africa and Asia the scorpion, which is from six to

[1] *Guy's Rep.*, 1862.

ten inches long, is so venomous as to cause by its bite, at times, loss of life. Olive oil is the usual application for the wound, but liquor ammoniæ is probably better. Brandy and ammonia should be given internally when great depression exists.

The bite of the spider is very similar in its effects to that of the scorpion, though the wonderful stories as to its poisonous qualities are now regarded as fabulous.

Serpent-bites are often serious, and at times fatal, the poison being squeezed into the tissue in the act of biting from a special apparatus situated at the base of the upper fangs. In England the *viper* is the only poisonous reptile, and, although some local and constitutional disturbance may follow its bite, a fatal result rarely ensues.

The *cobra di capello*, *rattlesnake*, *whipcord snake*, and *phoorsa snake* are the most venomous.

In some cases the poison seems to spend its effects upon the nervous system, killing by convulsions or coma; in others, its local effects are the more important.

Dr. S. Weir Mitchell of Philadelphia, who has carefully studied the effects of poison by the rattlesnake, states that the bite is sometimes followed by pain of a pricking or burning character, which gradually becomes more intense, also by bleeding, swelling, and discoloration of the injured part and tissues around, these symptoms depending upon the effusion of blood into the cellular tissue. The wounded extremity becomes larger and the pain greater, the skin assuming a mottled marbly aspect. As secondary effects inflammation and disorganization of the tissues occur; the inflammation assumes more the character of the phlegmonous erysipelas and is associated with glandular enlargement and suppuration, followed by gangrene as a common consequence.

Great depression of the nervous system and general prostration are the most prominent constitutional symptoms, with profuse cold sweats, vomiting, dyspnœa, and diarrhœa, and jaundice often precedes death.

When the dose of the poison is large or the susceptibilities of the patient acute, death may take place at once from general prostration and local stagnation of blood in the wounded extremity. In the case of a keeper of the London Zoological Gardens who was bitten in the nose by a cobra death took place in little more than an hour after the infliction of the wound, and half an hour only had elapsed when he was apparently dying, being unable to speak, swallow, or support himself; the pupils became dilated, the face livid, the heart's action feeble, and he was scarcely conscious.

Mitchell has recorded a case which proved fatal in five and a half hours. Of others, one died comatose, another with dyspnœa and dysphagia, a third felt sleepy and died without agony.

On the other hand, patients at times recover suddenly even when the symptoms have been severe, as if the poison had suddenly lost its power. More commonly, however, death ensues; and when recovery follows, it is only after severe local suppuration and sloughing, leaving a maimed and useless limb.

After death Mitchell found ecchymoses in the thoracic and abdominal viscera, purpuric in their nature and clearly caused by a want of normal coagulating power in the blood; this altered condition of the blood, indeed, is the most common effect of snake-poisons, and it is stated in some cases to last through life. Hence, in bites from the Indian phoorsa snake there is said to be a hæmorrhagic tendency during life. After death Mitchell could never detect the least alteration in the blood cells in acute cases, but in exceptional examples of chronic poisoning he found a few globules indented. In chronic cases, also, where there has been time for the poison to act upon the blood, the want of coagulating power in the blood is very constant, and putrefactive changes rapidly follow.

Dr. Halford of Melbourne says he always found the blood after death dark and fluid. It also contained germinal nucleated cells, which he regards as molecules of living foreign matter thrown into the blood from the venom; and he accounts for the asphyxia and death by the increase and multiplication of these molecules, which take place at the expense of the oxygen normally wanted in inspiration.

Sir J. Fayrer tells us, however, that he has never been able to detect these changes in the blood, although the poison affects the blood primarily and the nervous centres indirectly through it.[1]

TREATMENT should be most energetic; otherwise, the depressing influence of the poison will soon paralyze all action, a few seconds often being enough for the absorption of the poison.

Locally, the aim should be to arrest the absorption of the poison by fastening a ligature firmly on the cardiac side of the wound, by excising the wounded part, and by the application of nitric acid, carbolic acid, or the nitrate of silver.

[1] *Indian Annals of Med. Science*, 1870.

Fayrer records that the natives of India apply a ligature not only just above the bite, but at several places on the limb at intervals of some inches; they then place a red-hot coal upon the wounded part. The danger and difficulty lie in not applying the ligature quickly enough. The ligature must also be tightened to the utmost, till the circulation is entirely arrested and the part is livid with retained blood. The punctures should then be scarified, to allow the blood to flow freely, and the cautery or caustics afterward be applied.

Constitutionally, the best treatment lies in the administration of ammonia and stimulants in sufficient quantities to maintain the action of the nervous and circulatory systems, and thus to keep the patient alive while the poison is being worked off or becomes exhausted; for the man who is dying from snake-bites is perishing from rapid exhaustion of nerve force. Any other measure that can rouse and stimulate the failing nervous energy may also be employed.

Fowler's solution in full doses every half hour for four hours is said to have been useful. Iodine has also been advocated, and olive oil internally in full doses has been highly praised. In countries where poisonous snakes abound different roots have their reputation, such as the guaco, the sacræ vitæ ancora, radix corineæ, decoction of Virginia snake-root, etc., etc.; but Fayrer, after repeated experiments, believes them to be utterly useless.

Halford has inferred from his experiments that the injection of twenty to thirty drops of a solution of one part of strong liquor ammoniæ to three parts by measure of water into one of the veins of the wounded limb, accompanied by the local application of liquor ammoniæ to the part, is a specific; but Fayrer, who has tried the practice, has failed to find the success looked for. Mitchell advises ligature of the cardiac side of the wound, or excision, amputation, or destruction by cautery or escharotics of the poisoned part, and even *suction* of the wound immediately after the bite, as the poison has no influence in the stomach. He thinks well, also, of the injection into the wound of iodine or ammonia, and says the natives believe the local application of olive oil to be the best. M. de Lacerda communicated in 1882 to the Paris Academy a note in which he asserts that a one-per-cent. filtered solution of the permanganate of potash injected beneath the skin or into the veins counteracts very effectively the poison of snakes. With this local treatment the patient is to be kept up by hope, the action of the heart sustained by stimulants quite irrespective of quantity, and the general powers maintained by nutritious food. By these means, "if the person be not thoroughly poisoned, we may help him to recover. If he be badly bitten by one of the more deadly snakes, we can do no more" (Fayrer).

Bites of Diseased Animals.

Hydrophobia, meaning the "dread of water"—which is more correctly termed "RABIES"—is a disease contracted from the bite of a rabid animal through its saliva or mucus. It appears at all seasons of the year, and is, as a rule, fatal.

It is more common in temperate regions of the world than in the torrid and frigid zones. It is unknown in Australia, New Zealand, Greenland, and Kamschatka.

Blaine and Youatt affirm that in animals rabies is entirely due to a traumatic action—viz., the bite of some rabid creature inflicted on another previously free from the disease. Fleming, the most recent authority, tells us, however, that the virus of rabies may under certain favorable conditions be generated directly without the intervention of any infecting medium, although at present we are in complete ignorance of the conditions on which its spontaneous production depends. All animals bitten do not contract the disease, as is proved by Renault of Alfort, who caused dogs, horses, etc., to be bitten several times, and even inoculated them, when, out of 99 cases, 67 contracted the malady, and 32, or one-third, escaped. Fleming calculates that 30 or 40 per cent. of people who are bitten by mad animals go mad.

In the *dog* there are three well-marked stages of the complaint. The *first* is the *melancholic*, characterized by melancholy, depression, sullenness, and fidgetiness; the *second*, the *furious*, by excitement or rabid fury; and the *last*, the *paralytic*, by general muscular debility and actual *paralysis*.

"The dog," writes Trousseau, "looks ill and sullen after a period of incubation of a very variable length; he is constantly agitated, turning round and round inside his kennel, or roaming about if he is at large. His eyes, when turned on his master, have a strange look in them expressive of sadness as well as of distrust. His attitude is suspicious and indicates that he is not well: by his wandering 'he seems to be seeking' for

a remedy. He is not to be trusted: if he obeys at all, he does it slowly; if you chastise him, he may in spite of himself inflict a fatal bite." "His agitation increases: if in a room, he runs about looking under the furniture, tearing the curtains and carpets, sometimes flying at the walls, at others jumping as if to catch flies; the next moment he stops, stretches his neck, and seems to listen at a distant noise. He probably then has hallucinations of sight and hearing."

"This delirium," says Youatt, "may still be dispersed by the magical influence of his master's voice: all these dreadful objects may vanish, and the creature creeps to his master with the expression of attachment peculiar to him."

"There follows then an interval of calm; he slowly closes his eyes, hangs down his head, his fore-legs seem to give way beneath him, and he looks on the point of dropping. Suddenly, however, he gets up again; fresh phantoms rise before him; he looks around him with a savage expression, and rushes against an enemy which only exists in his imagination. By this time the animal's bark is hoarse and muffled: loud at first, it gradually fails in force and intensity and becomes weaker and weaker. In some cases the power of barking is completely lost; the dog is dumb, and his tongue hangs out through his half-opened jaws, from which dribbles a frothy saliva. Sometimes his mouth is perfectly dry and he cannot swallow, although in the majority of cases he can still eat and drink. When he cannot drink, he will appear to lap fluids with great rapidity; but on looking closely it will be seen that he merely bites the water. He can still, in some cases, swallow solids, and he may then swallow anything that is within his reach—bits of wood, pieces of earth, straw, etc."

"Toward the close of the second stage of rabid fury the dog often breaks his chain and runs away; he wanders about the fields, being seized from time to time with paroxysms of fury, and then he stops, from fatigue, as it were, and remains hours in a somnolent state. He generally dies in a ditch or retired corner, apparently from hunger, thirst, and fatigue."

Veterinary surgeons do not say that he dies from asphyxia brought on by spasm of the pectoral muscles or by convulsions. The disease runs its course in from five to eight days, and it is the same in the dog, cat, horse, and wolf, from any of which man may become inoculated.

In man the disease may show itself at any period from six weeks to a year after the inoculation, although Fleming and Bouley assert that the incubatory period in man varies from one to two months, and that after the third month the chances of immunity are great. Thamhayn (*Schmidt's Jahrbuch.*, 1859), in an analysis of 220 cases, showed that in 49 the symptoms appeared within a month, in 98 during the second, in 29 during the third, and in 26 during the fourth, month, 16 of the remaining cases showing themselves within twenty-six months, two cases only maturing at a period of four and five and a half years respectively. But these cases are always doubtful, and are probably examples of hysterical or *nervous hydrophobia*. Fleming,[1] however, records some striking cases which seem to show that the latent disease may be induced or brought into activity by mental agitation.

The disease may attack the infant at the breast or the aged, the male or the female, and during the incubative stage no disturbance of the general health is usually observed. Van Swieten has pointed out that during this period such a disease as variola may run its course without any modification, two poisons thus coexisting in the same frame.

After the incubative stage has passed the *first symptom* usually displayed is that of sadness, the victim either not suspecting his complaint or carefully avoiding mentioning the circumstance. His sleep is disturbed; he is fidgety, sighs deeply, and avoids society; he is troubled by noise or is very irritable and ill-tempered. The *second stage* will be marked by an aggravation of all these symptoms, but there will be in addition pain in the region of the heart with some irregularity of the pulse: rigors will soon appear, which, says Trousseau, "are true convulsions of all the muscles of the body;" and, lastly, the characteristic symptom of dread of water—not as fluid, however, but as connected with the difficulty of drinking. The sight of water is frequently sufficient to bring on shuddering, yet it is when the patient carries water to his lips that he is seized with the typical terrors. A rabid man is always rational and tries to drink, but the attempt excites terror and the expression of his inability. His eyes become fixed, his features contracted, and his countenance expressive of the deepest anxiety; his limbs shake and the whole body shivers. The paroxysm lasts a few seconds, then subsides, but only to be renewed on the slightest breath of air touching his body; for *hyperæsthesia* is one of the most marked symptoms of the affection.

[1] *Rabies and Hydrophobia*. 1872.

During the calm, nausea, or even vomiting, may appear, and priapism is often a most distressing symptom. Sudden terror of an unknown kind haunts the mind and imaginary calling of fiends often exists. Dr. Bergerons records a case in which the patient heard the ringing of bells and saw mice run about over his bed.

In the third and last stage the longing for drink becomes intense, with an increasing inability to take it; the voice becomes hoarse and the mouth full of a frothy fluid. The patient tries to get rid of this by spitting, and then becomes frightened at its results. In some cases he fears that by contact this fluid may propagate the disease. Convulsive seizures increase in frequency and intensity, the spasm of the respiratory muscles threatening life; at last a fatal spasm takes place, and death by asphyxia ensues.

Cause of Death.—In the dog death results from paralysis; in man it is due generally to asphyxia, and in exceptional cases to exhaustion.

Duration of Disease.—This painful affection rarely lasts longer than four days, though it has been fatal in sixteen hours and has lasted as long as two or three weeks. Thanhayn shows that 56 out of 202 cases died within forty-two hours, 73 in forty-eight hours, 38 between the second and third days, 19 between the third and fourth days, 7 in five, 5 in six, and 4 in seven days.

The seat of wound or cicatrix rarely shows anything unusual. In three or four cases out of a hundred it may be slightly painful, irritable, and inflamed, or the seat of a neuralgic pain, which in some instances is very severe and of the nature of "aura," as in epilepsy.

Diagnosis.—Taken as a whole, there is no disease like hydrophobia. In a certain sense it resembles tetanus, yet the two, in their general features, are unlike. They may, however, occur together, and so good an observer as Dr. J. W. Ogle has published a case of combined tetanus and hydrophobia in the *British and Foreign Medico-Chir. Review*, 1868.

What Trousseau has called nervous hydrophobia—that is, true dysphagia brought on by a dread of rabies—may, however, be mistaken for it; "but the sudden invasion of this complaint, generally coming on through the person recalling to mind or hearing the relation of a case of true hydrophobia, and the duration of the dysphagia over the period of four days are amply sufficient to characterize the complaint and to enable the practitioner to persuade the patient that he is suffering from mere nervous symptoms which will vanish as soon as he ceases to fear. Besides, in nervous hydrophobia there is dysphagia only, but no general convulsions, the spasm affecting the pharynx alone, while the breathing goes on with regularity."

In the very early period of the disease, during its incubation, Drs. Marochetti, Magistel, Xanthos, and others, have called attention to the presence of pustules or vesicles near the frænum of the tongue, known in Greece as *lyssi;* and they assert that if these lyssi are cauterized all manifestations of disease can be prevented. Should these observations be confirmed, a valuable means of diagnosis as well as of treatment in the very earliest stage of the disease will have been found. These lyssi are said to show themselves at an earlier period in proportion to the amount of poison deposited in the wound. Marochetti made early incisions through the vesicles, and then cauterized the surface with a red-hot iron, with, he states, invariable success.

Pathology.—There are no pathological lesions peculiar to hydrophobia—at least, none such have as yet been described. Mr. Durham, in a case that occurred at Guy's in 1865, carefully examined the cord, prepared after Dr. L. Clarke's method, and found extreme congestion of the gray matter of the cord and numerous minute patches of extravasated blood in different sections. More recently Dr. Benedikt of Vienna has made out that in dogs "the pathological process in this disease consists in acute exudative inflammation, with hyaloid degeneration, which doubtless arises from the exudative infiltration of the connective tissue of the brain" (*Wiener Mediz. Presse*, June, 1874; *London Med. Rec.*, September 30, 1874).

Treatment.—In all cases of bites from dogs or animals in which the faintest suspicion of rabies exists free cauterization with lunar caustic should be performed. Youatt states that he adopted this practice in upward of four hundred cases, and four times on himself, with complete success, and that in all these there was no doubt as to the dog being mad. With such a result no other caustic need be used: when this is not at hand, any acid, caustic alkali, or cautery will suffice. When the escharotic cannot be obtained, the part may be excised, a ligature being fastened beforehand on the cardiac side of the wound. Some surgeons advise amputation.

Mental stimulants, in the way of inspiring hope and removing fear, must be freely administered, and such general treatment as may be needed. No drug has yet been

found that has the least influence on the disease, either in preventing or curing it. Dr. Marochetti's treatment of the lyssi is the only one that can claim any degree of success. How far the constant administration of chloroform would influence the disease is a question that has yet to be put to the proof. To prevent asphyxia from taking place, tracheotomy, as suggested by Dr. Marshall Hall, is a justifiable measure, the operation being based on a good theory, although it has never been performed on the human subject. By it the immediate risk of death from asphyxia would be rendered impossible and time given for remedies to act or for the disease to run its course. It seems that six or seven days is the utmost period for the disease to be in existence. If life can be prolonged thus far, the hope of a good result may be entertained. Anything that can tend to prevent death and keep the patient alive is useful. Tracheotomy is one of these means and deserves trial, wine and food being valuable adjuvants.

When a dog is known to be mad, it ought to be destroyed; but when any one has been bitten by an animal in which there is a suspicion, but no evidence, of madness, it should be kept, although apart from others and guarded, as time will prove the truth of its condition and do away with the morbid fear of "rabies" that may have been excited by the injury.

Glanders.

This is a specific disease given to man by inoculation from the horse. Dr. Elliotson first recognized its true nature, and described it under the term "Equina." It shows itself in two forms. In one the disease attacks the mucous membrane of the nose and the neighboring glands, and is then termed "*glanders;*" in the other it affects the lymphatics of the body generally, giving rise to tumors or a knotty condition of the subcutaneous glands called "*farcy buds*," and is therefore called "*farcy.*"

In man these two forms are generally found together.

Symptoms.—There is said to be a stage of incubation varying from two to fifteen days from the inoculation, after which febrile symptoms with excitement appear, followed by the specific eruption. The pains in the limbs accompanying the febrile condition are generally associated with tenderness wherever glands exist, and on examination some enlargement of these glands will be found. The eruption is very characteristic, being made up of a crop of vesicles, which become pustular and are very hard, resembling those of variola more than anything else. They are arranged in groups with inflamed bases, the face, neck, and abdomen being, as a rule, more covered than the extremities; when close together, they become confluent. These pustules, with their indurated bases, then soften down, leaving ulcerated excavated surfaces. They affect the mucous lining of the nose, giving rise to the discharge. Virchow says that "these so-called pustules are really due to the presence of a tenacious deposit in the corium of the skin, which has much resemblance to tubercle and microscopically is made up of an amorphous granular appearance mixed with cell elements, cell growths, and fat globules." This opinion is supported by the clinical fact that tubercles in farcy are often found in subcutaneous tissue, appearing as hard circumscribed blind boils or more or less diffused swellings. These soften down and give rise to extensive sloughing of the skin and surrounding parts, and are rarely absorbed. During the progress of the disease soft tumors not unlike pyæmic cutaneous abscesses appear about the body, and sometimes attack deeper parts. In the more advanced stages of the disease these tubercles or so-called pustules attack the larynx and the whole respiratory tract, and more particularly the lungs, and give rise to Virchow's pneumonia of glanders—an affection which consists of a series of tubercles beneath the pleura covering the lungs and surrounded by lobular pneumonic inflammation, as in pyæmia. These tubercles are said to have been found in the testicles, kidneys, pancreas, and joints. When they attack the nose—which they usually do at an early period, and often before they appear in other parts—the secretion from the nose is at first catarrhal, thin, and clear; subsequently it becomes thick, tenacious, and puriform, and is often mixed with blood; but in many cases it is altogether absent or not noticed till a later period of the disease. The face and head often swell from œdema and present a puffy, erysipelatous, shining surface; the conjunctiva also exudes a thick fluid, gluing the eyelids. The tonsils are frequently involved and often suppurate. As the disease progresses the swellings and discharge increase, the inflammation around spreads and becomes gangrenous, bullæ appear on the skin, the constitutional symptoms become typhoid, a low delirium sets in not unlike that from pyæmia, and death ensues from coma and exhaustion. When the glands and absorbents are involved, as in the farcy form, suppuration and sloughing are superadded to those already laid down.

The PROGNOSIS of glanders is most unfavorable, since recovery only takes place in the mildest cases of poisoning. The disease in its acutest stage has run its course in three days, and may prove fatal in a week, but in general it lasts for three or four weeks, and in very chronic cases life has been prolonged for months. In chronic "farcy" sloughing glands may leave large sores, which remain open for a long time; occasionally such chronic cases end by an attack of acute disease.

The post-mortem appearances have been well described in Poland's article, *Holmes's System*, third edition, vol. i., in two recent cases, in both of which there was an absence of nasal discharge. One was Dickinson's case, and the other Poland's. The first-mentioned subject died on the twenty-first day. The blood was found fluid, the muscles soft and rotten, the cervical and left parotid glands suppurating, the lower part of the right lung solid with gray hepatization, its tissues completely broken down and infiltrated with purulent fluid, and the left lung studded with numerous slate-colored patches of the size of hazel-nuts.

The second patient died on the thirteenth day. There was no affection of the lymphatic glands, but suppuration had taken place in the muscles of both calves of the legs, accompanied by local abscesses in other parts of the body, chiefly in the muscles; the joints were free from suppuration; there were recent patches of lymph on the pleura and lobular pneumonia in the base of the upper lobe of the right lung, which was in a state of gray hepatization; throughout the lower lobes of both lungs were smaller hepatized masses; the liver was free from disease.

Billroth lays great stress on the presence of hæmorrhagic abscesses in the muscles as being characteristic of the pyæmia of glanders.

Mode of Inoculation.—In man the poison is generally communicated through the nasal discharge from the horse or by the discharge from farcy swellings. Where the inoculation takes place from the latter the disease in man is more of the character of farcy. It can be communicated from man to man. The poison, to be absorbed, must be applied, as a rule, to a wound or delicate membrane; yet cases are on record where the disease has been set up by wiping the face with unclean hands or cloths.

Youatt states that the disease is not one-tenth part so common as it was, and, "generally speaking, it is only found as a frequent and prevalent disease where neglect and filth and want of ventilation exist."

Glanders, writes Dr. G. Milroy (*Trans. Epidem. Soc.*, vol. i.), is "a *general* as well as a *propagable* disease; it is extremely apt in some seasons to develop itself in foul, unventilated stables." Its development may, however, be controlled, even to absolute prevention, by the observance of simple sanitary rules.

TREATMENT.—To keep the machinery of life going and to treat symptoms upon ordinary surgical principles seems to be the best mode of practice, for there is no drug which has any influence on the disease. Abundance of fresh air should be provided, with good but not too stimulating food, accompanied by tonics, such as quinine and iron. Pain should be soothed by sedatives. When the nose is a source of trouble, it should be kept clean by washing and by a stream of water passed through the nostril, and rendered antiseptic by iodine, carbolic acid, Condy's fluid, or creosote, nitrate-of-silver solution, tannic acid, and other more stimulating substances being at times valuable. Where the throat is affected it should be sponged with some nitro-muriatic acid lotion, and a gargle of chlorate of potash should be used.

Abscesses and softened tubercles should be opened early and freely, poultices or fomentations being applied to the parts. Perfect cleanliness should, of course, be observed.

Glanders in the Horse, as Mr. Youatt tells us in his book on that animal, is chiefly to be recognized by the persistent *discharge* from the nostril and the singular *hardness* of the submaxillary glands, which become adherent to the bone from the effusion of inflammatory lymph around them. These glands are not very large except at the commencement of the disease; neither are they hot or tender.

When any doubt exists as to the nature of the disease, a condemned horse or ass should be inoculated with the nasal secretion of the suspected animal; and if the disease be genuine, it will be reproduced in a few days.

Equina mitis is a local pustular disease affecting the hands and body of those who dress the heels of horses affected with what Jenner has described as the "*grease*." It consists of an inflammation and swelling of the heels of the horse, attended with the discharge of a thin acrid matter therefrom. It is not unlike ecthyma or vaccinia, but more angry; the pustules are about the size of a sixpence; they suppurate on the third day,

dry up about the tenth or twelfth, and form scabs which leave cicatrices. The disease runs its course, and is to be managed by rest and cleanliness.

Malignant Pustule, or Charbon.

This disease has been more common in recent years than it was formerly, and I have seen at least a dozen of the seventeen cases that have been treated at Guy's Hospital during the last ten years. My colleague Mr. Davies-Colley has given an excellent account of it, and M. Bourgeois[1] has fully described it in a work entitled *La Pustule Maligne et Œdème Malin* (Paris, 1860).

The disease is doubtless due to a distinct poison communicated to man by direct contact with the body of, or with any material that has been in contact with, a diseased animal. At Bradford, where there was an outbreak of it in 1880, it was termed "wool-sorter's disease." At Guy's it is found to occur amongst those who work amongst hides in the neighboring tanyards. It is found chiefly on the exposed parts of man, such as the hands, fore-arm, neck, and face. It begins as a small red inflamed and itching spot, which in twelve or fifteen *hours* vesiculates, the skin beneath the vesicle appearing as a dry brown or black slough. In the course of the second day another crop of vesicles appear around the original seat of the disease, which run the same course. About this time the seat of the original disease becomes more swollen, appearing as a defined lump ("bouton"), the parts around being œdematous, and the whole subsequently sloughing. "The raised indurated area with its central blackish depression surrounded by small vesicles can hardly be mistaken for any other affection." In this stage of the disease there is little pain; the slough is always *dry, and there is no pus;* the sloughing spreads from the skin down to the subcutaneous tissue instead of, as in carbuncle, from the latter to the former.

This disease is usually rapid in its progress, four to nine days seeing its end. It is ushered in with rigors, followed by vomiting and *great* depression; often cold sweats and delirium occur, and the patient dies from the depressing influence of the animal poison before its local effects have had time to work. In young subjects the prospects of recovery are greater than in the old; and when the hands are involved, the chance is better than when the head is affected.

Fig. 21.

Bacilli from Charbon. (*Drawn by Dr. F. C. Turner.*) *Vide* Mr. Davies-Colley's paper.

By the microscope straight or slightly curved bacilli are found in abundance along the sheaths of the hair follicles and about the border of the eschar (Fig. 21). They are likewise found in the blood as well as in the secretions of the body. In the viscera they are the causes of local sloughs from embolic capillary plugging.

Treatment.—The disease, being at its origin local, should be locally treated; and there can be no doubt that the excision of the inflamed and vesiculated area is the best practice to adopt even in advanced cases. By this method thirteen out of the fifteen cases in which it was carried out at Guy's were cured, although in twelve the inflammation had spread to the surrounding parts or had involved the lymphatic glands, and the constitutional symptoms were more or less severe. In less severe cases the destruction of the local disease by the thermo-cautery may be resorted to, or caustic, such as the potassa fusa, as advocated by Bourgeois, or carbolic acid, may be substituted.

Tonics and diffusible stimulants are always of use.

SYPHILIS.

Syphilis is a constitutional disease the result of a specific animal poison introduced from without. Like other specific animal poisons, it is, as a rule, propagated by some local inoculation; but, unlike all others, it has, by its subtle influence through the parents, the power of affecting the unborn fœtus and the newly-born child. No other blood poison appears to possess this power—at any rate, to the same degree; and it is

[1] *Vide Med.-Chir. Trans.*, vol. lxv., 1882.

well to bear this important point of difference in mind, for in all other respects there is a strong analogy between all.

The poison, once introduced into the system either by inheritance (*inherited syphilis*) or by some local inoculation (*acquired syphilis*), manifests its presence in its own peculiar way by the appearance of a somewhat irregular although characteristic chain of symptoms. These are uncertain in the period of their manifestation after the inoculation, in the order of their appearance, and in their form and effects; yet they possess their own special features. They are *local* and *general*. They run their course, yet do not eliminate the poison. They may disappear for a time, to reappear in some other form. The poison may lie dormant for years, and in healthy subjects show no signs of its presence till some weakening influence has depressed the powers of its victim and given rise to a local affection in which the practised eye will read with more or less certainty the modifying influence of an antecedent syphilitic affection. The poison has been scotched for a time only, but not killed, and in the weakness of its possessor has reasserted its power. No other animal poison appears to have such tenacity of existence. Others produce their specific effects in a definite way and in a regular series of symptoms and are either eliminated or destroy life; they cease to act and become innocuous after having run their course, their power for harm being exhausted. The poison of syphilis, however, is so subtle that it is tolerably certain most of the secretions of a syphilitic subject are capable of producing the same disease in another, clinical experience having disproved Hunter's opinion that syphilis could only be propagated by the secretion of a primary sore, and Ricord's proposition that "chancre at the period of progress is the *only* source of the syphilitic virus." Indeed, it may fairly be asserted that a healthy woman, marrying a man who has had syphilis, but in whom all symptoms have long disappeared, may give birth prematurely to a dead fœtus, to a stillborn child, or to an infant that will, either at its birth or within a few weeks subsequently, show symptoms of syphilis, all these results being the effects of syphilis transferred from the father. On the other hand, no such result may ensue. Maternal heredity has a stronger influence than paternal. When both parents are syphilitic, the chances of a fœtus being affected are greatly enhanced. "The semen of a diseased man deposited in the vagina of a healthy woman will, by being absorbed and without the intervention of pregnancy, contaminate that woman with the secondary (constitutional) form of the disease, and that without the presence of a chancre or any open sore either on the man or the woman" (Dr. Porter, *Dub. Journ. of Med. Science*, 1857).

A healthy woman marrying a man who has had syphilis, but who has lost all symptoms of it, may—not must—acquire syphilis either through the medium of a blighted ovum or a series more or less prolonged of stillborn children, or through the medium of the utero-placental circulation.

A healthy woman giving suck to a child the subject of hereditary syphilis may acquire the disease through some fissure of the nipple, the disease locally and constitutionally manifesting its presence with all the intensity of a primary inoculation.

Again, the secretion of any true syphilitic sore, chancre, or mucous tubercle, whether of the mouth, nose, anus, vulva, or penis, is capable of transferring the disease; and the syphilitic poison may probably be simply absorbed by the vessels of a part (*physiological absorption*) without giving rise to any local affection. Hunter believed this, and Lane, Marston, and Lee have published observations that tend to support the theory.

"It should never be forgotten that it is the virus which infects the system, and that the sore is the mere local lesion, and not a necessary antecedent to infection" (*Committee on Syphilis*, p. 8). "It is impossible to predicate with absolute certainty of any given sore that it will or will not be followed by constitutional infection" (J. Lane).

It should never be forgotten that the poison of syphilis, however introduced into the system—whether inherited or acquired from primary sores or from the secretions of a syphilitic subject—is the same, and manifests its presence in much the same way.

It may be difficult in individual cases to make out the direct source of the contagion: but if we recognize the fact that the virus, however diluted in one subject, may, when introduced into another, behave as if it had been taken from a spreading primary chancre, the explanation of most clinical facts becomes easy.

Syphilis is an animal and a human poison; it is capable of propagation by any form of inoculation from the secretion of any syphilitic to a virgin subject in all its intensity; it may likewise be inherited. Nothing is known of its nature, although its effects are sufficiently familiar.

How, then, it may be asked, is syphilis to be recognized? Is it to be recognized in its primary inoculation, or is it only to be known by its constitutional symptoms?

It has been already stated that most authorities are agreed upon the fact that there is no form of local sore or chancre that can be said with certainty to be the result of the local inoculation of syphilis. In the cartilaginous indurated sore with enlarged indurated glands there is every probability of syphilis manifesting its presence, and in the multiple, suppurating, non-indurated chancre there is every probability of no such symptoms appearing. But in the first form such symptoms may not, and in the second they may, appear; consequently, as a law this distinction becomes of little value. Indeed, syphilis as a disease can only be known by the manifestations of its constitutional symptoms, and not by the inoculation, in the same way as smallpox, when propagated by inoculation, is only to be recognized by the eruption, and not by the local appearances resulting from inoculation.

Acquired Syphilis.

Cause.—Acquired syphilis is contracted through inoculation from a chancre, from a syphilitic mucous tubercle, condyloma, or other syphilitic sore, or from the secretions of a syphilitic subject, the secretion of one form of syphilitic sore from one subject being capable of producing a chancre of another form in another subject.

Drs. Maury and Dulles[1] have traced it to a "tattooer" with mucous patches using his saliva to moisten the coloring-matter employed in his work.

Mr. John Morgan of Dublin, by experiments, has been led to believe that "the discharge of a syphilitic female produces on *syphilitics* the sore identical with that produced from the soft sore or chancre."

After inoculation, a certain time, which varies from six to twelve weeks, usually elapses before the poison manifests its presence. In exceptional cases the symptoms of syphilis may appear within the month or fail to appear for four or more months, but every week that passes after the third month without their manifestation lessens the likelihood of their appearance; and when six months have elapsed without syphilitic symptoms showing themselves, the probabilities of their doing so are very slight.

The different forms of syphilitic inoculation will be considered under the head of "Chancre."

Dismissing, therefore, the consideration of the character of the sore to which the poison of syphilis usually gives rise with the simple reminder that there is positively no specific sore, the constitutional symptoms of syphilis now claim attention; and the variety of forms they assume is very striking. They usually show themselves primarily upon the skin in the form of an eruption, or upon the mucous membrane of the alimentary canal, as indicated by sore tongue and throat, while some amount of fever and constitutional disturbance at times precedes their appearance. This "syphilitic fever" varies according to the nervous susceptibilities of the patient.

The skin eruption may be only a rose rash, *roseola*, giving rise to a mottling of the skin or to a more lasting staining. It may assume the papular form, *lichen;* the pustular, *ecthyma;* the vesicular, *rupia;* the tubercular, ulcerating or non-ulcerating, or the scaly, *lepra* or *psoriasis*. Bullæ are rare except in hereditary disease; when present, they indicate a cachectic condition.

The mildest form of roseola may last but a few days and disappear, or leave a dusky coppery stain behind of some durability.

The *lichen* will soon show the copper tint, and as it flattens may become a tubercle, and this a scale, the skin, after the desquamation of the scale, showing much the same as the macula of the rose eruption.

When the eruption is tubercular at the first, the same series of changes will be seen, the raised, indurated, or spongy tubercle as it withers usually showing a scale upon its surface and then flattening down to a macula.

The *lepra* and *psoriasis* appear as inflamed patches more or less extensive, as in the non-specific forms, the epithelial scales varying in thickness and the fissures in depth. The psoriasis commonly appears on the palms of the hands and the soles of the feet.

All these eruptions have a copper-colored tint, more particularly after their first appearances have faded. But what is still more characteristic is the fact that upon the same subject several forms of eruption are often found together, the macula, papule, pustule, tubercle, and scale passing one into another.

[1] *American Journal of Med. Sci.*, January, 1878.

What determines the form of the eruption at its first appearance is not known. Why syphilis in one man should manifest its presence by an eruption of maculæ, in another by a papular or scaly eruption, and in a third by a pustular, tubercular, or ulcerative form, is not known. The theory propounded by Carmichael—that each sort of eruption has its own form of local sore or inoculation—was ingenious, but is not supported by facts; and the generally-received opinion is that the peculiarity or power of the infected patient has more to do with these phenomena than the nature of the poison itself. The pustular and vesicular eruptions are more prone to appear in cachectic than in the robust subjects, and an ulcerative action is more likely to accompany—or, rather, to follow—their appearance; the base of the pustule or of the vesicle, and at times the substance of the tubercle, break down and give rise to a troublesome and spreading ulcer.

Affections of the Mucous Membrane.—As the *outside* skin in syphilitic subjects is attacked by eruptions, simple and ulcerative, so the *inside skin or mucous membranes* is equally involved. "Every form of syphilitic affection of the skin," writes Lee, "has its counterpart in the mucous membrane; but the appearances will be modified by the comparative thinness of the structure, by the absence of cuticle, and by the little disposition these parts have to take on the adhesive inflammation." The mucous tubercle is the more common form, and is found in the organs of generation, tongue, mouth, lips, nose, palate, throat, rectum, and anus, and occasionally in other parts of the alimentary canal. It is known also in the larynx. At times these tubercles break down and ulcerate, giving rise to irregular excavated sores.

Moist tubercles may appear in syphilitic subjects at any part of the body where two skin surfaces are in contact, associated with moisture. When they are found between the toes, they are known as *rhagades;* and when about the orifice of a mucous passage, as a condyloma.

Syphilitic sore throat may appear as a mere mucous patch upon the surface of the mucous membrane, or at times as an ulceration of this patch, while at others it shows itself as a distinct affection, the throat becoming swollen and of a livid color and rapidly passing into ulceration. These ulcers may attack the soft palate, pillars of the fauces, tonsils, or pharynx, and present every kind of appearance, shape, and character. They may be serpiginous like the trail of a snake, horseshoe shaped or circular, superficial or excavated with sharp edges, inflamed, sloughing, or indolent. By themselves they are not typical of syphilis, however suspicious, and other concomitant symptoms are required to determine the diagnosis. The mucous patch is the most characteristic. No ulceration is typical, although the sharply-cut excavated ulcer is the most unmistakable. In hereditary syphilis this form of excavated ulcer is rare, though I have seen the perforating ulcer of the soft palate in an infected infant a month old.

Syphilitic disease of the tongue is a very troublesome affection and manifests itself in a variety of ways; it appears more commonly in the form of aphthous and mucous patches, ulcerating or otherwise, but not unfrequently the whole thickness of the organ is infiltrated with the gummatous syphilitic material, either as an isolated nodule or as a general infiltration. When this nodule has softened down and suppurated, a deep excavated sore or fissure may be left, not unlike that of cancer; and when this sloughs or is of a chronic nature, the diagnosis becomes still more obscure. In cancer, however, there is probably a more marked local induration than in syphilis, and rarely a sharp, well-defined edge. The history of the case is, too, very different (*vide* Chapter XII.).

The mucous lining of the mouth, lips, nose, etc., is also equally liable to syphilitic disease, either in the shape of aphthous and mucous patches or of ulceration not unlike that found on the throat or tongue; indeed, the disease of one part of the mucous membrane is the same as that of others, the local appearances and symptoms being modified only by the peculiarities of the part.

In ulceration of the rectum syphilis bears an important part, and as a cause of stricture it is not rare. When present, the disease usually spreads upward from the anus, the bowel being in some cases superficially, in others deeply, infiltrated and ulcerated. This form of disease is more common in women than in men (*vide* Chapter XVI.).

Syphilitic disease of the periosteum shows itself in the form of nodes, and rarely as a single node. If the tibia be involved, several swellings exist; and the same occurs in other bones, particularly the cranium. The swelling is merely an effusion of the gummy material beneath the periosteum. When the bones are attacked, the disease is mostly chronic and too often ends in the death of the part—*i. e.*, in necrosis.

Symptoms.—In disease of the periosteum extreme tenderness and pain with local swelling are the chief symptoms. When the bones are implicated, the pain is of a constant aching character, and this is always aggravated toward night; but there is neither

such swelling nor so much tenderness as there is in the periosteal affection. In disease of the bones of the skull the dura mater and brain may become secondarily affected.

It must not be thought, however, that syphilis and its effects are confined to those parts of the body that come under the immediate notice of the surgeon. It is hardly probable that both ends of the alimentary canal should show evidence of the affection without some part of its intermediate twenty-five feet being implicated, or without some of the compound glands that are associated with it being involved. The pathologist knows this to be the case, and recent research has confirmed Wilks's observation (*Guy's Reports*, 1863) that "the extent of the influence of syphilis is only commensurate with the tissues of the body," and that "there appears to be scarcely a tissue which may not be affected, and always in one particular and characteristic manner. The internal organs may be affected equally with the external—not only the cranium, but the brain within it, or the nerves; not only the muscles of the limbs and tongue, but the heart; not only the pharynx, but the œsophagus; not only the larynx, but the trachea, bronchi, and lungs, also the liver, spleen, and other viscera."

"The peculiar effect of syphilis on the system," says the same writer, "shows itself in a disposition to the effusion of a low form of lymph or fibro-plastic material in nearly every tissue of the body, occasionally modified in character to a slight extent by the organ in which it occurs. In solid organs or in the interior of the tissues there is found a more or less circumscribed deposition of an albumino-fibrous material, whilst on the surface of the body a similar material may constitute merely the base and border of an ulcer." In the testicle this is well seen (Fig. 22).

Fig. 22.

Half a Testicle infiltrated with Syphilitic Deposit. (2351[68]. Prep. Guy's Hos. Mus.)

Pathology of Syphilis.—In these observations the whole pathology of syphilis is included; for, whether syphilis involve skin, mucous membrane, connective tissue, muscle, bone, periosteum, or a viscus, the same exudation exists, either as an exudation and induration or as an exudation breaking up with ulceration.

This exudation is the same in all stages of syphilis, in all tissues, in hereditary as well as in acquired syphilis. When the exudation is reabsorbed, a recovery is said to have taken place; when it breaks down, suppuration ensues. When it attacks the external tissues, "secondary symptoms" are said to exist; when the internal viscera or the bones are affected, the symptoms are called tertiary.

Affection of Bones and Larynx.—In cachectic and feeble subjects, where visceral mischief has a tendency to appear, syphilitic disease of the organ may occur. The bones, if affected, are liable to become necrosed; the larynx, to ulcerate; and the skin, when affected, to suppurate as well as ulcerate. In fact, syphilitic disease in the feeble and cachectic is as liable to be associated with disorganizing changes as any inflammatory or other affection. The longer the disease has existed, the greater, also, is the probability that the viscera and the tissues of the body generally will be involved. But in all other respects the effects of syphilis are the same. The virus, as it affects the body in all its different ways, is the same; at all times it is the same; the so-called *secondary* and *tertiary* syphilis are the same, for these terms have no definite signification. They have, I believe, tended to confuse rather than clear the subject, and were framed when the pathology of the disease was but little known. Syphilis is clinically known by certain constitutional symptoms, and pathologically by certain morbid conditions. It may manifest its presence in different subjects in different ways, involving now one tissue, then another, with no apparent law regulating its action. In one patient a tissue may be involved early; in another, late; but the node on a bone, the nodule of lymph on the iris, the indurated gummy tumor in the connective tissue or in a muscle, the puckered nodule of fibrous tissue beneath the peritoneal covering of the liver, the mass of fibre tissue poured out in a syphilitic testicle, are all alike. These differ only in their symptoms and effects according to their position, yet whether they occur soon or late after the primary inoculation is a matter of no clinical importance.

"While syphilis is thus unsparingly general in its attacks upon organs, yet it plays over much the same series of organs as other diseases; vulnerable or much-abused organs which suffer disproportionately from common causes of disease suffer also in much the same proportion from syphilis, while the thyroid, spleen, capsules, deep-seated bones, and, indeed, generally those parts which are not obnoxious to other 'common' diseases, escape

also in syphilis" (Moxon, *Med. Times*, June 24, 1871). In fact, beyond the local inoculation, syphilis fixes upon, or rather attacks, an organ much as any other disease, possessing no special predilection for one organ or tissue in preference to another, the so-called secondary and tertiary affections having no real difference save only in the surgeon's mind.

Treatment.—There is no remedy in the Pharmacopœia that can be relied upon as a specific for syphilis, although there are many that have a very beneficial influence in aiding the disappearance of the symptoms; they can, however, do no more. It is, indeed, a question whether the disease is really ever cured—whether a person once under the influence of syphilis is not really like one brought under the influence of vaccinia; which means that his body has been so affected by the poison as to be influenced by it for life. After successful vaccination a second inoculation rarely takes as it does in a virgin subject, and after true syphilis a second attack rarely if ever ensues, Porter's law being tolerably proved—"that the influence of syphilis never returns upon itself or recontaminates the source from which it had been derived" (*Dublin Quart.*, 1857). Ricord, Lee, and others have proved that the soft or non-infecting chancre is the only one that can be inoculated with success on the same subject. It is true that in a large number of cases syphilis appears to be cured, that the symptoms disappear, and that the health of the patient is re-established; yet it is equally true that in such cases, after the lapse of years—it may be, even after a quarter of a century—the existence of former syphilis is again recognized if the health of the patient is lowered. So long as the powers of the subject who had syphilis remain good, no evidence existed of its presence; but when these failed, the poison reasserted its claim to recognition. It must, however, be stated with considerable confidence that nature, unassisted by art, seems incapable of eliminating the disease or of arresting its progress.

On Use of Mercury.—In former times it was thought that in mercury the surgeon possessed a specific against the disease; and when all chancres were looked upon as syphilitic and mercury was administered, a large proportion of supposed cures were recorded, no constitutional symptoms showing themselves.

In modern times, however, when it is known that at least three out of every four cases of chancres of the penis are local venereal affections and not syphilitic, the real success of the mercurial plan is acknowledged to be less extensive than was supposed, although in syphilis—that is, when the constitutional evidence of the disease is present—the power of mercury in getting rid of the symptoms is indisputable.

In strong and healthy subjects, therefore, when syphilis is present either in the form of skin eruption, sore throat, or other affection of the mucous membrane of the intestinal or respiratory tract, mercury is beneficial. The best mode of using it is generally supposed to be by inunction—*i. e.*, the rubbing of mercurial ointment about the size of a nut, or, what is better, of the oleate of mercury, ten-per-cent. strength, the size of a pea, into the axilla twice a day till the gums are touched, and after then only once a day. Dr. B. G. Babington recommended the inunction in adults to the soles of the feet, the rubbing in being performed by the action of walking. The internal administration in bark of the bichloride of mercury in doses of one-sixteenth of a grain three times a day is a good form of administration, as is also the green iodide of mercury in grain doses twice a day, with Dover's pill. Some surgeons still use the blue pill with opium. During the last eight or ten years I have been using the mercurial suppository twice a day, and have been greatly satisfied with its action; the drug acts as well thus as by the mouth and in no way interferes with digestion or the functions of the abdominal viscera. Indeed, I am disposed to think it by far the best mode of administering mercury; I know of no objection to its use. Next to this plan, the calomel vapor bath is the best.

The most convenient calomel vapor bath, writes Lee,[1] is one which was made at my request by Mr. Blaise. In this apparatus the lamp which sublimes the calomel boils the water at the same time. In the centre of the top, immediately over the wick of the lamp, is a small separate circular tin plate, on which the calomel is placed; around this is a circular depression, which may be filled one-third with boiling water, the apparatus being placed on the ground and the lamp lighted. The patient then sits over it with an American cloth cloak or mackintosh fastened round his neck. He thus becomes surrounded with calomel vapor, which he is generally directed to inhale for two or three separate minutes during each bath. In doing this the patient should not put his head under the cloak, but simply allow some of the vapor to escape from the upper part and breathe it mixed with a large proportion of common air. At the expiration of a quarter

[1] *Holmes's Surgery*, third edition, vol. iii.

of an hour or twenty minutes the calomel is volatilized and the water will have boiled away, a portion of the calomel being deposited on the patient's body. The patient may then gradually unfasten his dress and put on his nightgown, but must not wipe his skin. If he prefers it, he may go to bed in the cloak and wear it. The bath ought to be used every night, and five or ten grains of calomel is the quantity that should be evaporated.

Bricheteau, Lewin, and Sigmond have employed the hypodermic injection of mercury with some success, throwing in fifteen minims of a solution of corrosive sublimate, four grains to the ounce of water.

Iodide of Potassium.—For feeble cachectic subjects, however, mercury is ill adapted, and for such the iodide of potassium in five-grain doses, gradually raised to ten, or more, will do all that is needful. In London practice it is generally required to be combined with some tonic, such as bark, quinine, or iodide of iron. The combined use of mercury and iodide of potassium will occasionally be of great value.

When the mucous tracts are involved, the addition of some alkali, such as the bicarbonate of potash, in ten-grain doses, to the iodide is advisable. The addition of the compound spirit of ammonia to the bark mixture is also useful.

When the symptoms begin to yield, the treatment must be continued; indeed, the effects of the drugs, whatever they may be, should be kept up for at least six months after the disappearance of all symptoms, otherwise a relapse will ensue.

Comparison of Mercury and Iodide.—Comparing the effects of the two drugs together, it may be asserted that the mercurial plan of treatment is more applicable to the early than the late symptoms of syphilis; that in cases of relapses or of late syphilis the iodide of potassium is preferable, although under both circumstances, in exceptional cases, one plan of treatment will succeed where another fails. When iodide of potassium cannot be tolerated, iodide of sodium may be substituted.

Diet.—During the course of syphilis the patient should live on simple, nutritious, but non-stimulating, diet. Wine and beer should be given in moderate proportions, spirits never allowed, and smoking, as a rule, should be interdicted.

When mercury is being employed, the skin should be kept warm and the feet dry, all sudden chills being bad. When suppuration or ulceration exists in any form of syphilis, mercury is rarely applicable; iodide of potassium combined with tonics is then the best drug, with or without opium. Sarsaparilla has no specific influence in syphilis; it is a pleasant vehicle, but nothing more. Opium combined with other drugs is at times of great value; with mercury it is invaluable. It may be given in small doses whenever the nervous system has been overwrought and there is great irritability of pulse.

The syphilitic affections of the mouth, tonsils, throat, tongue, etc., are expedited in their disappearance by the local application of nitrate of silver, chromic acid, gr. v to x to the ounce, chlorate of potash, boracic acid, or borax gargle; constitutional treatment should be simultaneously employed.

The mucous tubercles of the genitals and other parts are most successfully treated by the local application of calomel, which should be dusted over the diseased surfaces through a muslin bag. A good rub with nitrate of silver at times expedites the cure. The parts should be kept well dry.

Condylomata are not so amenable to the calomel treatment as the moist tubercles; they may, however, be successfully treated by the local application of the chromic-acid solution, nitrate of silver, or sulphate of copper, by a lotion of bichloride of mercury gr. ij to the ounce of water, or of black wash. When the growths are very fleshy, excision is the best practice.

In ulceration of the throat iodide of potassium, in doses varying from six to fifteen grains three times a day, is of great value, with the local application of the nitrate of silver in stick or strong solution; a gargle of alum, chlorate of potash, or borax, a drachm to a pint of water, is also good.

In laryngeal disease the iodide must also be given quite as freely; and when ulceration has commenced and seems to be unaffected by general treatment, tracheotomy claims serious consideration, because, unless the larynx can be kept quiet, repair will not go on, and so long as ulcerative disease is present a sudden spasm of the glottis may occur and render imminent the death of the patient. The operation should, however, only be undertaken when the disease is steadily progressing in spite of treatment, and if it is clear that the larynx will be destroyed as a vocal as well as a respiratory organ unless some steps be taken to stop its progress. Of these steps there are none equal to tracheotomy, for all surgeons are familiar with the fact that even under the most extreme conditions of disease repair goes on in the larynx directly the tracheal tube has been intro-

duced, and physiological rest is given to the organ (*vide* paper by author, *Clin. Soc. Trans.*, 1868).

In the *gummy tumors* of the tongue, muscles, and cellular tissue large doses of the iodide with tonics are as beneficial as they are in the *periosteal* affections of syphilis.

Treatment of Internal Syphilis.—There is reason, however, to believe that in the visceral as well as in other diseases which may be looked upon as the sequelæ of syphilis, or as the result of the cachexia caused by the disease and the remedies employed for its removal, iodide of potassium alone has little influence. Dr. Wilks has shown how the lardaceous and waxy diseases of organs are found after syphilis, and every one knows how little amenable to treatment these affections are. Dr. Dickinson has, however, done something to prove that they are due to a want of alkalinity in the blood, and are to be prevented, and in a manner cured, by the medical use of alkalies. With the same view a non-nitrogenous diet should be allowed.

During the later period of the disease, when the gummous depositions take place, whether it be visceral, osseous, glandular, or otherwise, iodide of potassium in full doses is of great value. In the sequelæ, in waxy or lardaceous disease, it is of little use, alkalies with tonics being then apparently the best. Upon this knowledge it is probable that the late Mr. Aston Key based his advocacy of lime water and the infusion of sarsaparilla in the syphilitic cachexia.

Hereditary Syphilis.

That syphilis is capable of being propagated by hereditary transmission is a clinical fact generally recognized, constituting the main distinction between syphilis and all other animal poisons. To what an extent this influence spreads is still a debatable question. According to some observers, instead of diminishing, the radius of its action appears to be yearly increasing.

That the child of a parent who has had syphilis *may*—*not must*—inherit the disease is generally acknowledged, and when both parents have been affected the probabilities of its transmission are, doubtless, increased; but data are still wanting to determine under what circumstances the offspring of such parent or parents is likely to be born healthy.

There is, however, some reason to believe that when the mother is at fault the early conceptions are more likely to be blighted and the later come to maturity; whilst when the father is at fault the first conceptions show few, if any, signs of the affection, the symptoms becoming more marked in each succeeding one, till at last the ovum becomes blighted and the wife constitutionally affected.

The probabilities of the child being affected, as well as the degree of the affection, turn, likewise, much upon the period of time which has elapsed between the disappearance of the constitutional symptoms in the parent and the date of marriage.

Daily experience proves, however, that a man who has had syphilis and lost all traces of it under treatment, who enjoys good health and marries a healthy wife, may be blessed with healthy children in whom no traces of syphilis can be found; but the same experience also indicates that these subjects, marrying in a less vigorous condition or lapsing into bad health, may give rise to diseased offspring.

A certain number of children succumb in their mother's womb to syphilis solely because they are already affected with the disease. At other times the children come into the world with lesions unmistakably syphilitic; while in the great majority of cases the child who inherits syphilis has at first the appearance of health and some weeks after birth presents signs which betray the evil transmitted to it from its parents, it being usually from the first to the third month of extra-uterine life that syphilis manifests itself in the new-born child. Cullerier gives a year as the latest time for the disease to show itself.

With respect to the symptoms of hereditary syphilis, it may be well to assert at the beginning that, with the exception of the primary inoculation, they are much the same as those of the acquired disease. Affections of the skin are found associated with those of the mucous membranes, bones, or viscera, and these manifest themselves in no definite order.

At birth the child may be plump and fat, and for some days appear healthy in every respect. After the lapse of a few days some difficulty in breathing will probably appear, with symptoms of cold in the head, these so-called "*snuffles*" being always suspicious. At this time, if the skin be carefully examined, more particularly about the buttocks and feet, some eruption will be seen. This may be simply a staining of the skin or a more definite papular, vesicular, or pustular rash: it may be associated with some affection of

the internal skin or mucous membrane, mucous patches or condylomata showing themselves at the anus, about the mouth or within it, around the nose or other parts. The seat of the eruption is greatly determined by the degree of cleanliness observed, the irritation of dirt and moisture in any locality in syphilitic children being followed by condylomata or mucous patches.

The orifices of the nose, mouth, and anus are at times fissured in a very marked manner, and occasionally leave traces of the disease which can never be mistaken even years afterward. In the annexed drawing these alterations about the face are most typically shown (Fig. 23).

When the disease is allowed to run its course, the child's general condition suffers; it becomes emaciated and puny, the digestive organs become deranged and refuse to assimilate food, however good, while vomiting and diarrhœa are common consequences. Evidence of starvation soon appears; the skin becomes baggy and of a peculiar dusky hue; when not covered or scarred with eruptions, it may have a jaundiced appearance; and the child will probably die from what is called marasmus, which means wasting from starvation.

When the disease does not run so rapid a course, other symptoms show themselves. It may be in the skin, bones, eye, ear, or viscera.

In the *skin*, subcutaneous or submucous tissues the disease may appear in the form of *gummy swellings* or *tumors*, which may break up and give rise to irregular excavated cellulo-membranous abscesses. In the *bones* the disease may show itself as nodes, the humerus appearing to be the bone most commonly affected, though I have seen several instances in which the bones of the skull were frightfully involved.

Fig. 23.

Hereditary Syphilis. (*From life.*)

In the eye the symptoms are well known; *interstitial keratitis*, a form of disease, according to Hutchinson, which is peculiar to hereditary syphilis, generally shows itself between the ages of eight and fifteen years. It appears as a diffused haziness of the centre of the cornea, unattended with ulceration; this haziness begins in independent patches, which subsequently coalesce, the cornea at a later date appearing like ground glass. The affection is attended with photophobic pain about the orbit and the sclerotic injection. It generally involves both eyes *seriatim*. Under treatment the disease may be arrested; but when it is severe, patches of haziness remain which interfere with vision and at times cause complete blindness (Fig. 23).

Iritis is another complication, though a rare one, as is *choroiditis*, and also *amaurosis*.

Deafness is not unfrequent, the hearing failing without any external disease, such as otorrhœa. In most cases both ears are affected.

Hydrocephalus and syphilis are also allied. *Syphilitic* disease of the testicles is also to be met with. I have seen several cases of this nature, and the most marked was in a boy four months old, the third child of syphilitic parents, who had snuffles and mucous patches on the lips. Each of the testicles was an inch and a half long and very hard. The disease was cured by mercurial treatment.

There is reason to believe, moreover, that in hereditary as in acquired syphilis every organ of the body, in different cases, may be found diseased, the viscera of the cranium, thorax, and abdomen, with the glands generally, as well as the skin, mucous membrane, muscles, nerves, and bones.

It is difficult to decide how far the syphilitic poison follows the subjects who inherit it. It is no uncommon event to find a child entirely free from all evidence of constitutional syphilis born of parents who had previously given, and may subsequently give, birth to stillborn or diseased offspring. A healthy child may stand alone in a long series of conceptions as a living proof of the power of life even over such a poison as syphilis.

I have also before me the notes of an instance of twins born of syphilitic parents; one passed through all the series of complaints common to hereditary syphilis, while the other escaped altogether—that is, at the end of a year and a half no symptoms had appeared.

I have the notes of another case of twins, born under like circumstances, in which the symptoms appeared in one at the end of a month, and in the other in the fourth month.

Such cases as these would appear to show that the manifestation or non-manifestation

of the symptoms of hereditary syphilis depends much upon the personal power of the child who inherits it, a strong child throwing off or eliminating the poison, while the weak falls under its influence, since in the case of the twins above mentioned there can be no question as to the similarity of the conditions under which they were placed. In hereditary syphilis this conclusion is founded upon strong evidence, and in the acquired it is at least probable.

Affections of the Teeth.—Amongst the evidences of hereditary syphilis established by Mr. Hutchinson there are often present in the permanent teeth important indications—so important, indeed, that when present the existence of hereditary syphilis may with some confidence be pronounced. They, however, exist only in exceptional instances of hereditary syphilis. "*The central upper incisors of the second set are the test teeth;*" these are usually short and narrow, with a broad vertical notch in the edges, and their corners rounded off (Fig. 24). Horizontal notches have nothing to do with syphilis.

Fig. 24. Fig. 25.

Syphilitic Teeth. Healthy Teeth.

"Next in value to the malformation of the teeth," writes Hutchinson, "are the state of the patient's skin, the formation of his nose, and the contour of his forehead; the skin is almost always thick, pasty, and opaque. It also shows little pits and scars, the relics of a former eruption, and at the angles of the mouth are radiating linear scars running out into the cheeks. The bridge of the nose is almost always broader than usual, and low; often it is remarkably sunk and expanded. The forehead is usually large and protuberant in the regions of the frontal eminences; often there is a well-marked broad depression a little above the eyebrows. The hair is usually dry and thin, and now and then the nails are broken and splitting into layers. Interstitial keratitis is pathognomonic of inherited taint; and when coincident with the syphilitic type of the teeth, the diagnosis is beyond a doubt."

In Fig. 23 every point in this description is illustrated except with reference to the teeth, which were unusually good.

There is, however, good reason to believe that the children of syphilitic parents *may* be affected by the poison in a way which cannot be classed amongst any of the ordinary forms of hereditary syphilis as described.

Treatment.—To help the disappearance of the symptoms of hereditary syphilis remedies are of great value, and in an infant showing evidence of any constitutional power the prospects of a recovery are very good. When the child is being suckled, whether the mother shows or not, I have for many years administered my remedies through the mother, giving her from six to ten or sixteen grains of iodide of potassium with quinine, or other tonic mixture, three times a day, half an hour before the child is put to the breast; and I have been much impressed with the excellent results of the practice. When this process acts slowly, I give the child in addition a grain of gray powder, with three or four grains of dried soda every night.

Before this I administered the gray powder and soda twice a day, or rubbed in about ten grains of blue ointment every night on the soles of the child's feet, the abdomen, or the axilla, but I much prefer the practice previously laid down. In young infants the mercurial ointment may be put on the belly-band and thus rubbed in. As the snuffles disappear the eruption and mucous tubercles fade, and the child begins to fatten and show signs of progress. The treatment should be kept up for at least a month after the disappearance of all symptoms.

The chlorate-of-potash treatment in some instances is doubtless attended with no unfavorable result, strong infants with care and nursing battling through the disease, and possibly eliminating it. But the weaker die when through more active measures they might probably have been saved. Many apparently hopeless victims of hereditary syphilis become under treatment strong and healthy infants.

A child with hereditary syphilis should under no circumstances be suckled by any other than the mother, for many a healthy wet-nurse has been inoculated by such a criminal practice. When the mother cannot attend to the child, it should be brought up by hand.

Serpiginous Ulceration.

This is a rare and somewhat singular form of venereal disease. It would seem to be more closely connected with the local suppurating non syphilitic sore than the syphilitic,

for it is rarely if ever associated with constitutional syphilis. It usually appears in the groin or thigh after a suppurating bubo the result of a suppurating non-syphilitic chancre, the opening in the groin spreading in crescentic patches of ulceration, one part of the sore increasing while a second is healing; when the cicatrix forms, it presents a smooth glazed appearance. This ulceration is most obstinate; indeed, medicine appears to have little or no influence on its progress, and it may so spread as to extend over the thighs and lower part of the abdomen and continue at intervals for years, but wearing itself out at last. I have seen one case in which it spread as high as the umbilicus and as low as the knee. The disease at one time promises to heal, and then spreads without any clear cause. It is often found, too, in apparently healthy subjects, and appears to follow some course of its own that is not yet understood. It should be added that this sore is capable of being inoculated upon the same subject, the point of inoculation taking on the same action.

Treatment.—Mercury and iodide of potassium appear to have little or no influence on this malady; and if the view indicated by its course be correct—that the disease is not syphilitic—such a result is only what should be expected. The local treatment of the sore seems to be the most important, and the best practice consists in the local application of some strong caustic, such as nitric acid, carbolic acid, or the cautery, either galvanic or actual, the patient being under the influence of some anæsthetic. The local application of iodoform or of resorcine in solution fifteen grains to the ounce of distilled water should also be tried. Opium in moderate doses is of use, and so also are tonics; but in a general way the subjects of this affection are in good health. In several instances I have found a sea-voyage of more value than any other treatment. In three cases the sore rapidly healed after the operation of skin-grafting had been performed.

When may a man who has had syphilis marry? is a question which is often asked; and to answer it with any degree of confidence is no easy task, assuming, as I do, that the opinions laid down in these pages are correct—that a man who has once had syphilis can never be pronounced free from its influence, and that the poison, once in the body, may reveal its presence a quarter of a century after all external evidence of its existence in the form of local disease has disappeared.

A man who has had syphilis may, therefore, when he marries so affect the ovum of his wife as to cause its death or produce some evidence of disease or feebleness; or if the wife be healthy and he himself in good condition and free from evidence of the disease at the time of conception, the offspring may escape altogether and appear as healthy as that of other uninfected parents. Indeed, it would appear that if a man marries when in robust or good health a year after all evidence of the disease has vanished, he may be the father of a healthy child; but if his general condition fails and he becomes cachectic, the poison may reassert its influence and manifest its presence by some feeble, or even diseased, condition of the subsequent offspring.

When the mother is affected with the disease, the same risks are run.

Every parent who has had syphilis runs the risk of giving birth to feeble or diseased offspring; these risks are diminished by the general vigor of the parents, and increased by diminished power. No man should marry so long as the slightest taint of the disease manifests its presence; but if in good health and free from all evidence of its presence for a year, marriage may be contracted. To ask for a longer delay when such a step is contemplated is unfair and unnecessary; a risk must be run, and the lapse of a longer period will not lessen it.

Inoculation and Syphilization.

Ricord was the first surgeon who employed inoculation for diagnostic purposes in venereal affections, and through his experiments he was led to the conclusion that "a chancre at the period of progress is the only source of the syphilitic virus." As a test of the simple suppurating sore it may now be employed, for a second sore can readily be obtained by inoculating a patient from the pus of his own primary one. Indeed, this process of auto-inoculation may be continued for a long series, but only with any effect from the suppurating sore. In the syphilitic sore no inoculation will take, and in the inoculation of common pus no reaction occurs, or next to none, a simple pustule probably alone appearing.

From these clinical facts it would appear that common pus, the pus from a suppurating non-syphilitic sore, and that from a syphilitic one are very distinct, including under the term "syphilitic" any sore that is followed by syphilis.

By inoculation, therefore, a surgeon may fairly determine the fact as to the nature of a chancre, and under some circumstances the evidence obtained by the practice may be valuable.

Syphilization originated in 1844 through some experiments of M. Anzias Turenne upon animals to inoculate them with syphilis, and in these he found that after a number of inoculations they became proof against the syphilitic virus. It was followed up by M. Sperino of Turin and extensively employed by Professors Boeck, Faye, and Bidenkap at Christiania, several hundred cases having been treated upon the principle, the object being "to cure syphilis."

The theory, as expressed by Boeck, "that the syphilitic virus by continued inoculation annihilates itself," was practically carried out by inoculating a patient the subject of syphilis with fresh matter from any active venereal sore of any kind till the inoculations failed to take. The inoculations were repeated every three or four days, first on the body, then on the extremities. When inoculation is no longer possible, "the treatment is finished and the patient has recovered his health."

Boeck never practised syphilization until the constitutional symptoms appeared; for, says he, "I cannot double a malady already present, so I am quite certain not to do harm to the patient." Syphilization is not used with equal success against all cases of syphilis. "In those that have not been treated with mercury the progress of syphilization will be regular; the syphilitic phenomena will vanish away, immunity will take place eventually, and recovery be attained with certainty. In those who have taken mercury syphilization is not so certainly useful; it ought to be tried. It does often cure syphilis entirely, and at least does good." These are Boeck's conclusions, but I need hardly add they are not those of British surgeons. The practice has been mentioned and briefly described, but not to be recommended. It has no single advantage, and is certainly loathsome. We are decidedly of opinion, write Lane and Gascoyen in an able article on the subject, that "syphilization is not a treatment which can be recommended for adoption. We consider that, even if it could be admitted to possess all the advantages claimed for it by its advocates, its superiority over other modes of treatment, or in many instances over no treatment at all, would not sufficiently compensate for its tediousness, its painfulness, and the life-long marking which it entails upon the patient" (*Med. Chir. Trans.*, vol. i.).

Vaccino-Syphilis.

That syphilis may be transferred by means of vaccination is a fact which must be honestly recognized, although where it has occurred it seems more than probable that something more than the unmixed lymph of the genuine vaccine vesicle had been employed, such as the blood of the vaccinfer; for no one can now well dispute the possibility of inoculating syphilis when the blood of a syphilitic vaccinifer is transferred with the vaccine matter to a non-syphilitic subject. Whether it be possible to transfer syphilis through unmixed vaccine lymph is still an open question. In this country such a misfortune as a syphilitic inoculation through vaccination has been happily rare, and only in recent days has the attention of the great body of the profession been directed to the subject. In Mr. Hutchinson's paper and in the report of the Royal Med. and Chir. Society for 1871 there will be found sufficient material to prove the truth of what has been written, and in Dr. Seaton's *Handbook on Vaccination* and in Dr. Ballard's work all that is known on the subject may be ascertained.

Instructions for Vaccinators.—Vaccinate only subjects who are in good health. Ascertain that there is not any febrile state, nor any irritation of the bowels, nor any unhealthy state of the skin, especially no chafing or eczema behind the ears or in the groin or elsewhere in folds of skin. Do not vaccinate in cases where there has been recent exposure to the infection of measles or scarlatina, nor where erysipelas is prevailing.

Lymph is to be used according to the following instructions:

1. In proceeding to use a charged capillary tube, snip off its two ends; then from one end of the tube blow the lymph through the opposite end upon the arm of one of the infants, over the place where the operation is to be performed, having had previously two or three other infants' arms prepared for vaccination. The lancet is then to be loaded from the drop and inserted into the arms of the children prepared to receive it, but enough is to be left upon the original arm to vaccinate that child. Unless the tube be very copiously charged, not more than two children are to be vaccinated from it. The insertion should be made in four spots, as hereinafter directed.

2. In operating with a charged ivory point *use no water to soften the lymph.* In this

mode of vaccinating the operator should make a few scratches *just through* the cuticle, only sufficiently deep to *damp* the surface with *blood*. These scratches should *be made in four spots*, each covering a surface, at nearly one inch apart. The scratches may be abrasions of the cuticle by fine parallel lines or by further cross-scratch. The operation may be performed on both arms when the surface available or the position usually selected is of limited extent. The operator should proceed with caution and take time. On no account should incisions be made and the point of the ivory inserted into them, and it should be borne in mind that the vaccine virus ought not to reach the subcutaneous cellular tissue. The child should be kept under observation till the spots are perfectly dry, and orders given that the arms *must not be washed*.

3. Selection of Lymph.—Never either use or furnish lymph which has in it any, even the slightest, admixture of blood. In storing lymph be careful to keep separate the charges obtained from different subjects, and to affix to each set of charges the name, or the number in your register, of the subject from whom the lymph was derived.

4. Never take lymph from cases of revaccination. Take lymph only from subjects who are in good health and, as far as you can ascertain, of healthy parentage, preferring children whose families are known to you and who have elder brothers or sisters of undoubted healthiness. Always carefully examine the subject as to any existing skin disease, and especially as to any signs of hereditary syphilis. Take lymph only from well-characterized, uninjured vesicles. Take it (as may be done in all regular cases on the day week after vaccination) at the stage when the vesicles are fully formed and plump, but when there is no perceptible commencement of areola. Open the vesicles with scrupulous care, to avoid drawing blood. Take no lymph which as it issues from the vesicle is not perfectly clear and transparent or is at all thin or watery. Do not, under ordinary circumstances, take more lymph from a vesicle than will suffice for the immediate vaccination of five subjects, or for the charging of seven ivory points, or for the filling of three capillary tubes; and from larger or smaller vesicles take only in like proportion to their size. Never squeeze or drain any vesicle. Be careful never to transfer blood from the subject you vaccinate to the subject from whom you take lymph.

5. Keep in good condition the lancets or other instruments which you use for vaccinating, and do not use them for other surgical operations. When you vaccinate, have water and a napkin at your side, with which invariably cleanse your instrument after one operation before proceeding to another.

With these precautions vaccination may be regarded as a perfectly safe operation; without them the risks of syphilitic inoculation, although slight, exist. They tell, however, but little against the enormous advantages of vaccination.

Lee, *Holmes's System*, third edition, vol. iii.—Marston, *Med-Chir. Trans.*, vols. xlv., xlvi.—Lane and Gascoyen, *Med.-Chir. Trans.*, vol. l.—Bumstead, *Edit. of Cullerier*, Philadelphia, 1868.—Porter, *Dublin Quart.*, 1857.—Lancereaux, *On Syphilis*, New Syd. Soc.—Wallace, *On Venereal*.—Carmichael, *On Venereal*.—Hutchinson, *Syphilitic Diseases of Eye and Teeth*.—*Report of Committee on Venereal Diseases*, 1868.—Turenne, Academie des Sciences, 1850.—Boeck, *Edin. Med. Jour.*, 1858.—*Dublin Journal*, 1857.

CHAPTER III.

TUMORS.

In the prepathological period, before the minute anatomy of healthy and diseased tissues was understood and the microscope had rendered intelligible subjects that still rested in darkness, *tumors* had from necessity been studied simply in their clinical aspects, and surgeons, in their attempts to classify them, were guided solely by the most obvious characteristics of the growths and by their real or fancied resemblance to the natural tissues of the body. As time advanced more ambitious attempts at classification were made, and the most important work was that of *Abernethy*, who at the beginning of this century published his *Attempt to form a Classification of Tumors according to their Anatomical Structures*. In that able production he asserted "that the structure of a tumor is sometimes like that of the part near which it grows, and sometimes unlike; that in many cases the nature of the tumor depends on its own action and organization and merely receives nourishment from the surrounding parts." He thus gave expression to

pathological truths of the greatest importance and that still remain incontrovertible. The next real advance was due to Bichat, who recognized the essential difference between tumors and the parasitic nature of the cysticercus and echinococcus, although by his followers this parasitic notion was carried out far too fully, for they looked upon cancer as the product of a parasitic growth of entozoa. It was left, however, to Lobstein of Strasbourg to embody Bichat's idea and to give it full expression, which he did by naming those tumors *homœoplastic* which were similar in structure to the natural constituents of the body, and those *heteroplastic* which were composed of products which differ from the normal tissues. Since that time countless workers have been examining tumors and attempting to classify them, one of the most prominent being Lebert, and to him must fairly be attributed the credit of assigning specific elements to specific tumors, each tumor having, in his opinion, a definite structure; cancer was to be known by the caudate fusiform cells that even now are looked upon by some as typical of the disease. This notion of specific elements was very feasible, for it simplified knowledge and induced men to think they had a ready means of deciding upon the nature of any new growth; and had it not been for Virchow, it is probable the theory would have long held its ground. In this learned pathologist, however, it found an opponent of consummate power; and, as his reasons for disbelieving it are the groundwork of his great book on *Cellular Pathology and Tumors*, it is well to have them in his own words:

"In Germany the doctrine of specific elements has from the first made few proselytes, and now it is entirely abandoned. From the commencement of my career I have been compelled to combat this error, and I believe that at the present moment we are in a position to demonstrate in every direction that there do not exist in tumors true specific elements which have no analogy with the normal tissues. It is enough for that to remember that the tumor, however parasitic it may appear to be, *is always a part of the body from which it springs*, and that it is not developed in an isolated manner at the expense of some juice, at some one place in the body, by the inherent force of this productive juice. To admit such a mode of development *de novo* was possible at a time when it was also believed that entozoa were spontaneously developed in the body at the expense of a liquid or an excretion, by equivocal generation, when no idea had been as yet formed as to how a cysticercus arrived in the abdomen and there was able to develop itself and grow. There was no other opinion which medical men could then form save that entozoa sprung from animal substances, either from the tissues themselves or from the intestinal mucus (*saburra*). In the present day, when it is known that entozoa always penetrate into the body from without—by a way often, it is true, extraordinary, yet always natural—this analogy can no longer be invoked. This is still more evident since we have come to know that in a free exudation there is no new element produced—that, furthermore, the elements of the body itself have a legitimate origin from father and mother (or, to speak more correctly, from father or from mother, for it is a case of parthenogenesis); so that we must completely abandon the idea that a tumor can develop itself in the body as an independent being. *It is a part of the body;* it is not merely contiguous to it, but proceeds from it and is subject to its laws. *The laws of the body govern also the tumor.* This is the reason why it is not an object of natural history that one can regard as foreign from the elements of the body; it is, on the contrary, to be looked upon as embraced within its limits. . . . . Hair may make its appearance and grow at a place where we do not expect to meet with hair, but no one will fancy or believe that feathers will grow in the human body. As a matter of fact, there are tumors in man which contain hair, and in cutting up geese tumors are sometimes found containing feathers; but if ever a man engendered a tumor with feathers or a goose one with hair, this would be a production *sui generis*, because the thing produced would deviate from the type inherent to the individual.

"*The type which in general governs the development and formation of the organism governs equally the development and formation of its tumors.*

"There does not exist a new, different, independent type.

"What is established by logic in this matter results also from the direct observations of tumors themselves. This is why I deny that there is any heterology in the sense in which it has been maintained since Bichat's time, or such as was supposed even before then—that is to say, that a tumor could develop itself and exist in the body in accordance with some quite new plan, some new law. I go farther: each species of tumor, whatever it may be, answers in its important parts to the elements of the body the type of which is known, and the capital difference amongst divers tumors resides in this—that tissues normal in themselves appear under the form of a tumor, sometimes in regions

where this tissue normally exists, sometimes in places where it does not exist in the normal state of things. In the first case I speak of it as *homology;* in the second, as *heterology.*

"Wherever a normal tissue appears at a point which already contains some similar tissue, then as a consequence the new tissue is identical with the old, so that the type of the new production answers to the type of the pre-existing tissue; in this case the new tissue, the tumor, is homologous. When, on the contrary, the new type does not correspond with the old one, when it deviates from the pre-existing type or that which is the original and normal one of the region, then there is heterology. But this latter has likewise its analogue in the body, only in another part of the body from that in which the tumor is situated.

"We cannot, in my opinion, distinguish tumors according to the tissues in such a fashion that tumors containing certain tissues are to be regarded as homœoplastic, whilst those containing certain others are to be set down as heteroplastic; quite the contrary, *the same kind of tumor may be, under certain circumstances, homologous, and under other circumstances heterologous.* The same sort of tumor may at one time appear at a point where it is merely the expression of an excessive development of the tissue normally existing at this point, at another time at a place where this tissue is not in existence and where its development is abnormal and strictly pathological Let us take an example. A tumor may be formed of cartilage. The cartilaginous tumor is homologous, not because it is formed of cartilage, but only if it springs from cartilage, if in this place there is cartilage already. Thus, a costal cartilage may be the point of origin of an enormous cartilaginous tumor; this is homology. But it is also possible for a cartilaginous tumor to be developed in the testis, which contains no cartilage, where this tissue should not be met with: here the same product constitutes an heterology."

"Homology" and "heterology" have, therefore, very different meanings as used by Virchow and other writers. In Virchow's language a tumor is *homologous* when it corresponds in structure with the tissue *in which it grows*, and *heterologous* when it deviates from that structure. A tumor that is homologous in one position may be heterologous in another. On the other hand, in the French and other schools a tumor is *homologous* when built up of elements naturally existing in some tissue of the body, *heterologous* when composed of elements that deviate from the natural structures, these definitions having nothing whatever to do with the position of the tumor. In Virchow's language the terms are relative; in that of other pathologists they have a definite clinical meaning of no slight importance, for homology means innocence and heterology malignancy in a tumor. Virchow, however, admits that his heterologous tumors are suspicious, although *every heterologous tumor is not of a malignant nature.* "There are a great many such tumors borne without any ill consequences, and whose properties are quite similar to those of which the nature is benign. Malignancy follows a certain scale among heterologous tumors, from species to species; and we are able to show how it is manifested more and more strongly, for the most part following two directions. In the first place, heterology is distinguished according to the degree which it attains. The tissues of connective substance have a much nearer relationship existing among themselves than they have with epithelial tissues or with the specific animal tissues. When, therefore, a cartilaginous or bony tumor is developed in connective tissue, or even a mucous tumor in adipose tissue, that is not nearly so heterologous as when an epidermoid tumor is formed in connective tissue or a tumor of cylindrical epithelium in a lymphatic gland. A cartilaginous tumor which is developed in connective tissue or in the tissue of bone is indeed heterologous, but it is not so to the same degree as an epithelial tumor or a muscular tumor would be in the same place. But a still more important circumstance is this—that tumors engender certain liquid substances which we speak of under the name of 'juice.' This is the humor or juice of the tumor, of which much has been said."

"This parenchymatous juice is sometimes related to the cells, sometimes to the intercellular substance; and, accordingly, it appears under the form of fluid, either intracellular or intercellular, contained in the cells or interposed among them in a liquid state like serosity. Whenever a tumor contains much juice, it gives evidence of more troublesome qualities and it possesses to a high degree the property of infection. A dry tumor of the epidermoid kind is by far less dangerous than a moist one; a soft cancer is much more to be dreaded than a hard one.

"The more a tumor is poor in vessels, the less it will extend its infecting action beyond the neighboring parts; but the more it is rich in blood vessels and lymphatics, the more it is traversed by the blood and lymph, the more the parenchymatous juices

are in contact with the blood, so much the more is the infection likely to become general.

"I give thus an interpretation of facts, but it is in accord with observation. The degree of contagiousness of tumors increases in proportion as they become more rich in vessels, and that alongside the vessels they contain an abundance of liquid materials. Every soft succulent tumor is suspicious, and that just in proportion as it contains many vessels and cells. The more the juice is intercellular and in contact with the vascular stroma of connective tissue, the more the malignant properties which are manifested by an ever-new excitation to the progressive production of the tumor.

"I ought, indeed, to speak more at length as to the nature of these juices, but, in truth, I do not know what to say upon the subject. The results which chemists have arrived at on this subject have no kind of value. Here the field is open to inquiring and progressive spirits, and I hope that hereafter researches will be undertaken in this direction, and that they may be crowned with success."

But, as this is not a work on pathology, I cannot allow myself to enter further into these speculations, and must refer the reader to Virchow's masterly work on *Cellular Pathology and on Tumors* for a fuller elucidation of the subject.

In the sequel I shall regard tumors in their clinical aspect alone, giving their anatomical characters only so far as they illustrate the practical aspects of the subject. All speculative pathological doctrines will be set aside as tending to confuse rather than to elucidate clinical phenomena until the day when pathological science shall have so far advanced as to allow of an anatomical classification of tumors being made that will fully dovetail in with that founded on clinical observation. The microscopical anatomy of tumors has been furnished by the pen of my friend and colleague Dr. Moxon.

I propose to lay down here some few pathological points which have an important clinical bearing, and which tend to illustrate the subject of the diagnosis of tumors.

A tumor may be defined to be a new growth, cystic or solid, infiltrating, separate from or continuous with normal tissues. It is an addition to natural parts, and it manifests its independent existence by its disposition to grow irrespective of the part in which it is placed.

All tumors, with the exception of the hydatid, are made up of one or more of the natural elementary tissues of the body in a rudimental or morbid state, and in no single example has any extraneous or new element ever been detected.

A mere increase or overgrowth of natural parts is a hypertrophy. Just as the natural body is built up of cells and fibres in one or other of their different forms, so tumors are made up of like elements, although, it may be, of unequal proportions. Tumors, like the natural tissues, differ, therefore, anatomically according to the nature of the elementary structure of which they are composed; and this again appears to be materially determined by the part of the body in which they are developed.

From this, therefore, a second leading principle may be fairly deduced—viz., *that all tumors partake of the nature of the part in which they are developed and are more or less made up of the elements which naturally enter into its formation.*

Hence a tumor developed in the stroma of a fibrous structure will probably be fibrous; if connected with bone, more or less osseous; and if situated in a gland, it will in all probability partake of the gland structure. But new growths never assume the complicated structure of a fully-developed gland: they only in a degree simulate it. Wilks well expresses it when he says that "the great difference between physiological and pathological formations appears to be that nearly all new growths are of the simplest composition, not putting on the form of the complex organs near which they may be placed, but consisting principally of cells and fibres." The cells and nuclei of a part, instead of developing into normal tissues, err in their course, multiplying and possibly growing, and, "whilst conforming generally with the part in which they are placed in minute structure and composition, yet they more and more widely deviate from it in shape and size" (Paget).

The practical bearing of these pathological principles is by no means unimportant, because to the surgeon who has once recognized the true position of a tumor there is a certain amount of probability as to its nature which will at once suggest itself to his mind. If the tumor is situated in the skin or subcutaneous tissue, a strong probability exists that it will be composed of some one or other of the structures of the tissue; thus it may be the sebaceous tumor, which is rarely found in any other position, or the fatty, for these two materials enter largely into cutaneous structures; or it may be one of the fibrous or fibro-cellular nature, fibre-tissue existing abundantly also in these parts. Should the tumor be located between the muscles of a part, the tumor will probably be composed of connective-tissue elements in the form of a sarcoma or myxoma. Should bone, again,

be the seat of the disease, some one of the elements of bone will to a certainty enter into its formation, the probability of its being an enchondroma, an osseous, or a myeloid tumor naturally presenting itself to the mind. And, lastly, should a tumor be present in a gland, such as the breast or prostate, the probability of its being an adenoid or glandular tumor cannot be overlooked; for pathologists now all recognize the fact of the close resemblance of tumors so situated to the natural gland structure. Even in malignant tumors, if modern recorders are to be relied upon, the same principle holds good; for carcinoma is now generally recognized to be an epithelial growth, and only occurs primarily where true epithelium already exists. Secondary growths can only be produced by the direct propagation of the epithelial cells, which may be transported from their primary seat either through the lymph vessels or as embola are carried through the blood vessels to a suitable place, where they develop like the germs of entozoa.

Tumors are either simple or cancerous, innocent or malignant, the simple or innocent approaching in their nature to the more completely developed natural structures of the body, even to the perfect glandular, and the malignant or cancerous simulating the more elementary or embryonic. As the normal tissues were formed from a simple cell, and in their higher grades are but a development of that cell or those cells, so the sarcomatous and cancerous element consists in a persistence of the simple cell type or that of the undeveloped embryonic nucleus. The group of cases called "recurrent" must be placed in an intermediate position; for, while in their earlier stages they tend to build up embryonic tissue, this subsequently becomes lost in cell proliferation.

In proportion, therefore, to the amount of the embryonic cell element in a tumor its cancerous tendency may be determined; and the greater the proportion of the fibrous or well-developed structure, the greater the probability of its nature being innocent or simple. The more a tumor simulates the natural structure of a tissue or gland, the greater the probability of its being innocent: the more a tumor simulates the undeveloped cell structure, the greater the certainty of its being cancerous; malignancy appearing to diminish in proportion as the cells become more fully developed. As, moreover, it is in the nucleus of a cell that the active principle of its growth is to be sought, so it is clear that the more the tumor is composed of nuclei, the more malignant is its nature; and the better the formation of the cell wall, the less malignant is the growth.

The nearer a new growth approaches, both in its elements and in the arrangements of its elements or structure, to the complex organs of the body, the greater are the probabilities of its being innocent, new growths under no circumstances equalling the perfection of a true gland tissue.

Simple tumors separate tissues in their growth, but never infiltrate; cancerous, as a rule, infiltrate and rarely separate. No more important practical point than the above can be adduced to aid the surgeon in his diagnosis of a tumor. A simple or innocent tumor, however long it may be in growing or large a size it may attain, will never do more than separate the parts between and beneath which it may be developed. The bones may be absorbed by its pressure, but they will never be infiltrated, and the skin may be so stretched and attenuated by its distension as to ulcerate or burst, but it can never be infiltrated with the elements of the tumor. This fact is well exemplified by a close examination of the margin of a cutaneous opening the result of overdistension, for it will appear as if cleanly cut, or rather punched, at its edges, and never thickened or diseased. An intra-cystic growth may project from it as a fungus and put on many of the appearances of a cancerous tumor, yet the margin of the opening will be free, and not infiltrated. In the cystic tumors of the breast this clinical fact is easily perceivable.

Simple tumors, by expanding parts, cause the cellular tissue around to become condensed and to form a capsule; consequently, most of the innocent tumors are encapsuled more or less completely. With the majority of cancerous tumors, however, a very different condition has to be described; for a cancer has the peculiar property of freely infiltrating all the tissues upon which it presses, at its base, round its borders, and upon its cutaneous aspect. As the tumor approaches the surface the integument first appears to be drawn down to it, and afterward seems as though glued to its surface. At a later stage the skin becomes infiltrated with cancerous elements, feeling to the finger firm, fibrous, or tuberculated; and when ulceration has commenced, the edges of the skin are palpably indurated, thickened, and infiltrated with cancerous products. The contrast between these different conditions of integument in the two classes of tumors is most marked and very important, forming a very valuable means of diagnosis in the extreme stage of simple or malignant tumors.

Diagnosis of Simple and Cancerous Tumors.—*Simple or innocent tumors affect the patient solely through their local influence. They grow by their own inherent properties, irrespective of the growth of the parts in which they are placed, have little disposition to soften down or ulcerate, and no tendency to multiplication in other tissues or to involve the absorbents with which they are connected. Malignant tumors not only affect the patient through their local influence, but have a marvellous tendency to multiplication in any part of the body. Through the lymphatic system they involve the glands of the part with which they are connected, while through the vascular system they spread to other parts. They are prone, also, to degenerate and ulcerate.*

When simple tumors are multiple, they invariably are found in the same tissue; when malignant tumors are multiple, they are mostly found in different tissues. Thus, amongst the innocent growths multiple fatty tumors of the skin are not uncommon; multiple fibromata of the uterus are often seen; multiple glandular tumors of the breast are met with, involving one or both organs; and there are records of multiple fibroplastic or myxomatous tumors. It is not seldom that multiple enchondromatous tumors and exostoses are seen, but in all these instances the tumors occupy one tissue.

In the malignant and cancerous multiple tumors no such description can be given, for they spread in ever-widening circles from the parent tumor, the cell elements spreading locally in connective tissue as freely as the floating blood cells move through the walls of the blood passages, as a colloid is penetrated by a crystalloid, wandering about in what are called solid tissues. They follow the course of the lymphatics and affect the glands, and at times seem to follow the course of the venous circulation. They recur by continuity of tissue as from constitutional reproduction, and Mr. Moore, in his work on *Rodent Cancer*, has referred to a case of Mr. de Morgan's in which from a cancerous tumor within the skull some detached fragments which had sunk in the fluid of the arachnoid adhered to the spinal cord and grew. They spare no tissue or organ, but invade one and all, without order or law, in their destructive objectless growth.

Recurrent or Intermediate Tumors.—All tumors cannot, however, be divided into the *innocent* and the *malignant*, for there are some of an intermediate kind which in structure approach the innocent, but in habit the cancerous, as they *recur* after removal. They have consequently been called *recurrent* tumors; but, as the habit of recurrence is not the only point in which they approach the cancerous tumors, it is better, perhaps, to term them *semi-malignant*.

I propose, therefore, to describe tumors under the following headings:

A. **Innocent Tumors,** or those composed of the normal adult tissues. This section includes Lipoma, Fibroma, Chondroma, Osteoma, Adenoma, Papilloma, Neuroma, Angioma, and Lymphoma.

B. **Semi-Malignant,** or those composed of embryonic connective tissues, including the Sarcoma and Myxoma. They form a class of tumors which in a measure belong to the one that precedes it as well as to the one that follows it, since it includes cases, such as some of the myxomata and sarcomata, that are very little malignant, and likewise some sarcomata that are very much so. Nor is that all, for it occasionally happens that some innocent tumors become malignant, and lymphomas which are classed as innocent are sometimes quite the reverse.

C. **Malignant,** or those composed for the most part of epithelial structures, including Epithelial and Hard and Soft Colloid Cancers and Rodent Ulcers.

D. **Granulation Tumors,** or those composed of granulation tissue, including Follicular, Keloid, Gummata, etc.

E. **Cysts.**

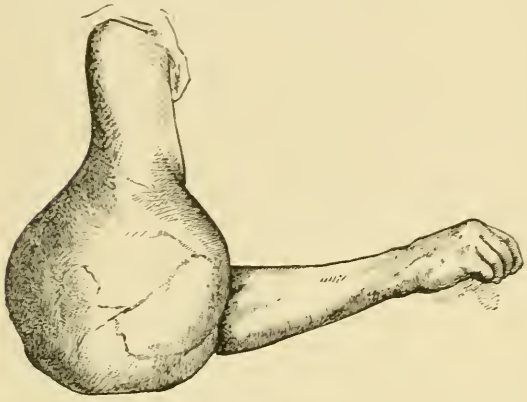
A. Innocent Tumors,

Or those composed of the normal adult tissue, vary with the tissues. They are innocent or benignant in that they do not, like cancers, infiltrate the parts in which they grow, but rather separate them, and are a source of trouble more from mechanical than other causes. When they interfere with life, they do so generally from pressure on important parts. They may stretch skin even to its rupture, but the margin of the skin-opening will be uninvolved in disease. In cystic breast tumors this is well seen.

1. Lipomata, Fatty Tumors, otherwise called "steatomata," are very common. They are found wherever fat exists naturally in the body; and as this material is more especially deposited in the integument, it is in and beneath this that fatty tumors are most frequently met with. They occur at all periods of life from infancy to old age, and are even congenital. They attack the male sex as well as the female, but they are three

times as common in the latter. They are generally single, but occasionally multiple. I have seen a case in which the whole integument was studded with them, and under these circumstances they are usually small. It is impossible to assign any valid cause for their development, hereditary and accidental influences having doubtful effects. They are troublesome only from their position and the deformity they occasion (Fig. 26), and are at times the seat of pain, though such a symptom must be looked upon as an accident due to their position.

Fig. 26.



Fatty Tumor of Thirty-Seven Years' Growth on Arm of Woman æt. 69.

These tumors are, as a rule, "encapsuled," although in rare cases they are "continuous" or "diffused." This latter variety differs only from the former in that they are made up of smaller globules of fat and are more dense, while they are more common about the nape of the neck and face than the encapsuled variety (Fig. 27); the large double chin is an example of the continuous lipoma, and congenital lipomata are generally of this nature. The encysted lipomata are most common on the shoulder, thigh, and trunk; some are deep-seated, as between the muscles of the limbs or within the abdomen or scrotum. Fatty tumors at times shift their position—that is, they drop downward; several such cases have passed under my notice in which the tumor has travelled some distance. Such an occurrence is peculiar to this form of tumor and suffices to fix its nature.

The DIAGNOSIS is not usually difficult. If subcutaneous, these tumors are "lobulated" and "encysted"—that is, are defined by a distinct boundary, their cyst-wall being formed by the condensed fibro-cellular tissue in which they are developed. To the hand of the examiner the tumor will feel more or less firm and made up of lobes; when frozen by the application of ice, it becomes harder. To the eye the tumor will, on raising it from its base and distending the skin, appear dimpled, and in parts the skin will be quite drawn inward toward the new growth. If the tumor be deep, a doubt may be felt; but practically the question is not of great moment, for it only refers to the nature of a simple growth, and not to its treatment.

Fig. 27.

Diffused Lipoma of Neck.

TREATMENT.—When no necessity exists for their removal, tumors should be left alone. When large and unsightly, cumbersome or growing, they should be removed by excision or enucleation. A single incision through the centre of the growth is the best and most expeditious method for turning the cyst out of its bed, which can be done readily by the finger. Where the growth is pendulous the whole should be cut off, leaving enough skin to cover the wound. After the operation the edges of the wound should be brought together by sutures and strapping and supported by steady pressure: rapid union usually follows. Fatty tumors, when removed, very rarely return. Curling has recorded a case, however, in which a recurrence took place, but so much connective tissue was present in that example as almost to remove it from the class of lipoma (*Path. Trans.*, vol. xviii., 1867). I have also removed from the buttock of a lady a lipoma of two years' growth the size of a fist, having removed from the same part a like tumor twelve years previously.

The "continuous" fatty tumor should never be removed unless under very urgent circumstances. The operation is comparatively formidable, so much dissection being required. In children, however, these tumors may be dealt with.

2. Fibromata are tumors composed of "hard" or "soft" fibrous tissue, the soft being composed of masses of "connective" and the hard of "fibrous" or closely-packed connective-tissue elements. The "soft" kind are found as outgrowths from the subcu-

taneous tissue, and frequently in the female external genital organs; they are known as "fibro-cellular growths." They are met with also in the lower extremities under the form of "molusceum fibrosum" (*vide* Fig. 28).

Some contain much fat, and thus approach the lipomata. These tumors are mostly outgrowths, and appear as the softer polypi and cutaneous pendulous tumors. The polypi of the nose are the best specimens of the looser kind of growths, as in consistence they vary from a watery pellucid pendulous outgrowth to a firm, more compact, and fibrous tissue. They are, however, always covered with mucous membrane with its ciliated epithelium. The softer tumors of the antrum are also of the same nature, as are the mucous polypi of the uterus, bladder, and rectum. In the rectum the tumor is intimately mixed with the glandular elements of the part. Amongst the outgrowths of the integument those of the male and female genital organs are the commonest. The tropical elephantiasis scroti is of this class. The pedunculated outgrowths of the skin are also of the same kind.

Fig. 28.

Case of Molusceum Fibrosum. (Mr. Davies-Colley's case.)

Deep-seated tumors of this nature are very rare. They do occur, however, in the connective tissue of the body, the intermuscular spaces of the thigh and arm being the commonest seat. They *are always surrounded by a capsule*, and when not confined by unyielding parts are more or less ovoid; at times they are lobed. They possess a smooth outline as well as an elastic feel; some of the softer kinds, indeed, give the idea of fluid. They are tumors of adult life, being rarely met with in children. They increase in size with variable rapidity, the amount of fluid they contain materially affecting this feature. The pendulous outgrowths, mucous or cutaneous, at times swell out and at others contract, while those of the skin appear shrivelled and loosely encapsuled. Those of the genital organs may attain a very large size, some which are on record having weighed as much as forty pounds. At times these tumors inflame, slough, or ulcerate in an indolent, but in no way a typical, manner.

The "firmer" kind are met with in many shapes. They are always solid, and mostly encapsuled. When, as in the uterus, mixed with the non-striped muscular fibre, the growth is known as "*fibro-muscular*" or as a "*myoma*" (Virchow's term). When associated with cysts, it is called "*fibro-cystic;*" and when with calcareous matter, "*fibro-calcareous.*" These varieties are found chiefly in the uterus. Fibrous *outgrowths* or *polypi* are commonly met with in the uterus, nose, pharynx, and rectum. They have been found in the intestine and other parts. Fibrous tumors are found likewise in the uterus and prostate, and *occasionally* in connection with the bones and periosteum, in the latter as an epulis. In those about the bones the elements of bone or cartilage are usually found.

The fibrous outgrowths have no capsule, but are continuous with the tissue from which they spring, and are made up of fibre tissue more or less closely packed and arranged in bundles or in concentric circles; they are but feebly vascular. Those of the uterus are the most typical (Fig. 29).

Fibrous tumors are always encapsuled and have a tendency to assume an ovoid or globular form when not confined; but when compressed or bound down by surrounding parts, they take an irregular lobular shape. In structure they are very similar to the outgrowths.

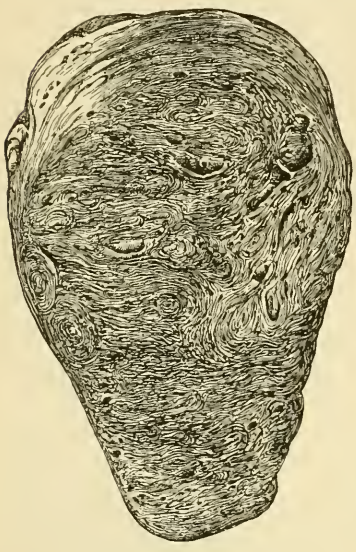
Fibrous tumors are firm, and occasionally most unyielding. They are slow in their increase and give pain only from their position. When bound down by a dense fascia or situated near a nerve, they cause much distress. They only interfere with life or comfort mechanically. They are usually single, except in the uterus and when in connection with the nerves. As they come under the notice of the surgeon, those connected with the periosteum or bones, called *periosteal sarcoma*, are the most common, and of all the bones the jaws are the most frequently affected by them. They are chiefly periosteal and appear as outgrowths (*vide* chapter on "Tumors of Bone"). They are found in the pharynx, on the lobule of the ear, and on the nerves as "neuromata."

The **subcutaneous fibrous tumor** is a hard movable tumor beneath the skin. It is usually small; but when of a less dense kind and more nearly approaching the fibro-cellular tumor, it may attain a large size. Under these circumstances the skin will become part of the tumor; it will then often ulcerate and allow the growth to protrude

through the opening and ulcerate, or even slough, and thus these tumors sometimes bleed freely. At times fibrous tumors seem to grow from the deep fascia.

Treatment of Fibrous Tumors.—Excision is the only treatment which offers any prospect of success; and when these fibrous tumors are removed, a recurrence is rarely met with. The fibro-muscular, fibro-cystic, and fibro-calcareous tumors are mostly uterine.

Fig. 29.



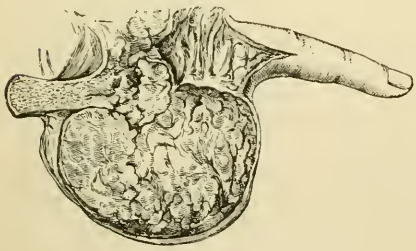
Fibrous Tumor.
(Drawing 397^{92}, Guy's Hosp. Mus.)

3. Chondromata, or cartilaginous tumors, are most commonly met with in connection with bone, but they are found in the parotid or submaxillary regions, the soft parts, as the testicles, intermuscular septa, and other parts.

They appear, as a rule, in young subjects, in people under middle age, and are far more common, according to my own notes, in the female than in the male. They are usually slow in growth, the majority having existed years before the patient seeks advice. The instances of tumors of rapid growth on record are rare. These tumors, when not outgrowths, are always encysted and have a smooth, tense, and elastic feel. In some examples they are uniform and even, in others bossy and nodulated; they rarely cause pain, and produce anxiety simply from their position and size. Those in the parotid or submaxillary region appear to grow superficially and to be movable, but they often dip down deeply into the tissues, and considerable care is required in their removal. In a case treated by my colleague, Mr. Durham, the tumor appeared more as a pharyngeal than as a parotid growth. As often as not they are very adherent to the surrounding parts. These simple parotid tumors rarely involve the facial nerve or cause paralysis, as do the cancerous. When the cartilaginous tumors grow *within* bones, they expand them into a thin shell.

Cartilaginous tumors are usually innocent, and consequently only separate the parts between which they are developed. They never involve the integument by infiltration, but only stretch it; in exceptional instances they excite inflammation and ulceration in the skin, with subsequent perforation; they do not affect the system through the glands, although it must be added that rare examples are on record in which cartilaginous tumors have returned and affected the lymphatic system like a cancer. Sir J. Paget has recorded such an instance in the *Med.-Chir. Trans.*, 1855, and De Morgan in the *Path. Trans.*, vol. xx.

Fig. 30



Section of an Enchondromatous Tumor expanding Metacarpal Bone.

The section of a cartilaginous tumor is fairly characteristic (Fig. 30). It cuts crisply and presents a smooth surface; it may appear of one mass or made up of many lobules. In some cases the consistence of the tumor is close and is composed of translucent or bluish masses of fœtal cartilage, as is best seen in the periosteal forms. In others it is loose and granular, as in those expanding the bones. In many of them fibrous or glandular tissue is intimately mixed with the structure of the tumor, the parotid tumor affording the best type of this kind. In the cartilaginous tumors of bone, bone elements are always present; in those of periosteum, fibrous elements; and where glands are involved, glandular structure. When cartilaginous tumors soften down, cysts are found, usually containing a dirty brown serous fluid, or simply filled with broken-down tissue and pus or with a more tenacious synovial kind of fluid.

Microscopically, cartilaginous tumors present diverse forms, simple fœtal cartilage cells, embedded in some cases in a hyaline or in a granular matrix, in others in a fibrous or glandular stroma, or even both in different parts of the same growth. The most typical form is that in which the cartilage cells are grouped together in masses surrounded by fibre tissue. From this type great deviations occur, the cells being more or less scattered

between the fibres. In some instances the nuclei of the cells are free and numerous, in others they are filled with granules or oil-globules, apparently degenerating. Occasionally the cartilage cells are developing and take on the mature form of bone cells (Fig. 40).

TREATMENT.—The removal of the cartilaginous growth is the only efficient treatment, but the practice must be determined by the position of the growth and all the other points with which the tumor is clinically surrounded. When removed, a return rarely takes place. Cases, however, are on record (the Guy's museum containing a few) in which a return ensued after a second or third excision; but such instances are exceptional.

The cartilaginous tumors of bone will be considered under the head of "Diseases of Bone."

4. **Osteomata, or osseous tumors,** naturally come to be dealt with after the cartilaginous, for the two elements are usually combined; and as in the enchondromata traces of bone may be found, so in the osseous tumors traces of cartilage may exist (Fig. 40).

These are found in several forms, as exostoses or bony outgrowths, as ivory or periosteal exostosis, and as tumors of bone. The ivory growth is peculiar to the bones of the skull.

The cancellous exostosis is almost always developed through cartilage and made up of tissue precisely similar to the cancellous tissue of bone. In some cases it is covered with a thin casing of compact bone, like the cartilaginous tumor growing within a bone, but in most it is covered with a layer of cartilage, by the ossification of which it grows. A diagram illustrating these points will be found in the chapter dealing with exostosis, and the clinical aspect of the subject will be again considered in the chapter on "Tumors of Bone."

5. **Adenomata, glandular or adenoid tumors,** are new growths simulating more or less perfectly the gland structure in the neighborhood of which they grow, and are not hypertrophies of the gland, but distinct tumors. In the breast the usual innocent tumor of the organ is of this nature, and is called *adenocele;* but it is also found in the prostate, uterus, lips, tonsil, thyroid, and integument. Fig. 41 represents admirably the microscopical features of the adenomata as a class, and Fig. 31 the appearance of such a tumor in section, some parts being solid and others composed of pendulous intra-cystic growths.

They are generally growths of young life, and are found during the active period of a gland's existence. They are always encapsuled, and can usually be turned out of their bed with ease on dividing the capsule. They generally assume a rounded or ovoid shape, and are distinctly movable beneath the integument which is not involved. "On section," says Paget, "they commonly appear lobed or intersected with partitions of connective tissue and are pale, grayish or yellowish-white, in some specimens looking translucent and glistening; in others, opaque: in nearly all, acinous or glandular. To the touch, some, especially the white and more opaque, are firm, tenacious, and elastic; others, especially the yellow and more glistening, are softish, brittle, slippery, and succulent, with fluid-like serum or synovia. Not rarely cysts are embedded in the solid growth, and these are filled with serous or other fluids like those which are found in the barren cysts of the mammary gland itself. In the labial and parotid glandular tumors portions of cartilage or bone may be mixed with the glandular structure, and sometimes, chiefly in the mamma, the glandular tumors appear as if formed wholly or in part of clusters of small sessile or pendulous growths, which fill cysts or partitioned spaces; thus they indicate their relation to the proliferous cysts and suggest that they originated in such cysts. The textures around the tumor are usually quite healthy, altered only by displacement." These glandular tumors are often single, but at times multiple. Thus, in the breast they may be many and so loosely encapsuled as to move about as in a bag; in the lips they are commonly numerous; while lymphatic glandular tumors are almost always multiple. They grow with very variable rapidity

FIG. 31.

Adenoma of the Breast, illustrating the Pathological Appearances of Adenoid Tumors.

—at times more slowly, at others with great rapidity. They require removal simply from the inconvenience caused by their mechanical pressure.

Treatment.—To remove them it is only necessary to divide their capsule and the soft parts covering them in and to enucleate them. This need not, however, be done under all circumstances, for these glandular tumors not only cease to grow, but at times disappear; thus operative interference should only be entertained when the growths are large or increasing or very painful. Medicine does not appear to have any influence in checking their growth.

The glandular tumors of special regions will receive notice in the different chapters devoted to their consideration.

Papillomata are found in the outside or inside skin and in the mucous membrane, while instances are on record where they were found on serous membranes. On the skin they occur as warts, cauliflower or sessile, and as condylomata. Some of the horny skin-growths are of this nature. On the mucous membrane they occur on the lips, larynx, hard and soft palate, tongue, and rectum, and as villous growths in the bladder and rectum. They seem to be a mere delicate outgrowth of subcutaneous or submucous tissue, with their natural epithelial covering, at times involving the gland structure of the part. They are usually innocent.

Neuromata, or fibrous tumors developed in and about a nerve, will be considered in a later chapter, as will the angiomata in chapter on the "Diseases of the Vascular System."

Lymphoma is a disease of the lymphatic glands which is at times local, at others general. When local it has, as a rule, local causes; when general, constitutional and is associated with leucæmia or leucocythæmia.

The glands are, as a rule, movable in the surrounding parts, and can be shelled out. In exceptional cases they are matted together, as in cancer, and, like it, are also disseminated as secondary growths. (For "Histology" *vide* Fig. 42.)

B. Semi-Malignant Tumors.

1. Sarcoma.—The semi-malignant tumors, or those composed of embryonic connective-tissue elements, include what are known as the "sarcomata" and "myxomata," and these clinically present a vast variety of shapes and types. They approach the simple growths in that they do not infiltrate tissues, but separate them; and they approach the malignant in that they are prone to recur after removal, and that on each recurrence they come nearer the characters of the cancer.

To the naked eye they are succulent, with every degree of solidity, but a section does not give milky juice on scraping, and it never presents the concavity like a cancer.

In some cases, where recurrence has taken place, the second tumor, doubtless, has been simply the external manifestation of a small growth which existed when the original tumor was removed, or the increased growth of a portion of diseased tissue that was unconsciously left. On two occasions when removing a mammary adenoma I have exposed a minute growth of a similar structure by the incision made through a portion of the healthy mammary gland to reach the principal growth. In both these cases, had the small tumor been left, a recurrence would have been recorded. In cases of recurrent fatty tumor or of the soft fibroma it is highly probable that a small portion of the tissue was left. On one occasion, when I was enucleating one of these, of several years' growth, from beneath the fascia covering the scapula, I discovered two smaller growths which might have been overlooked and would certainly have grown. Each tumor as it recurs generally becomes less solid, more succulent, and more rapid in its growth. With each recurrence the cell elements increase in proportion and in all ways; "later formed tumors assume more of the character of malignancy than the earlier." All these sarcomatous tumors are composed of round, elongated, oat-shaped, caudate, nucleated cells like those found in granulation and embryonic connective tissue (*vide* Fig. 43).

It must be observed that these tumors, as a rule, attack the young and healthy. They grow from a fascia or aponeurosis, are of slow growth, particularly at first, and destroy life only after many years and from local causes. They return either in the spot from which they originally sprang or from its immediate neighborhood. They simply affect the part mechanically by separating and surrounding tissues, but never by infiltrating them. The skin is stretched over the tumor, but never involved in it; and if destroyed, it is by ulceration from overdistension, while the absorbent glands are never secondarily involved, even in extreme conditions. Such tumors are to the hand more or less fibrous and lobulated, their fibrous feel being much influenced by their rapidity of

growth. When cut into, they present a more or less compact surface, a clear serous fluid infiltrating its meshes; while even the finest microscopical section will be found tough and tenacious and incapable of being pressed into a diffluent mass. Under the microscope they present an excess of nucleated cells and nucleated fibres, these, again, showing their tendency toward the characters of the malignant growth.

When a sarcomatous tumor springs from periosteum, it is often separated into sections by bands of fibres; and when it originates in bone, it may be similarly divided by thin plates or outgrowths of ossific matter, these plates or laminæ being sometimes distinctly separate, at others so closely packed together as to form something like a skeleton tumor (Fig. 32), the sarcomatous elements clothing the bony outgrowths or surrounding and covering them in. For diagnostic purposes the detection of these bony plates is of great value.

Fig. 32.

Sarcoma of Bone. (Prep. Guy's Mus.)

The treatment of recurrent tumors need not differ from that of the innocent, for as long as the disease is local there is a reasonable hope that it will at last cease to recur after removal.

Myeloid or giant-celled sarcomatous tumors are as primary growths generally found associated with bone, either growing from the bone, as in "epulis," or more commonly in the bone, and when in this position usually in its articular end. The term was given to the class by Paget on account of the likeness between its cells and those of fœtal marrow. Lebert called them "fibro-plastic," and Virchow "giant-celled sarcoma."

When these tumors are periosteal, they have the clinical features of a fibrous growth; when within the bone, they appear as chronic expansions of the articular extremity or shaft. When large and so expanded as to have burst through their osseous case, they appear cystic and semi-fluctuating, even to the extent of being pulsatile. They are usually slow in their progress, and often painless; and it is fair to suppose that many of the cases of cystic expansion of the articular extremity of a bone are due to myeloid disease. The disease is one of youth and young adult life, and the growth is usually single. It is not connected with any cachexia or glandular enlargement, as happens with cancer; and when removed, it rarely returns. Instances of recurrence, however, have occurred, and I have seen one. Sir J. Paget has recorded others.

A myeloid tumor presents in section a peculiar appearance. It may be solid or cystic in variable degrees; osseous matter, fibrous matter, or fluid may exist in different proportions; yet in every specimen the cut surface will present blotches of a pomegranate crimson or of a darker blood color, these tints mingling more or less regularly with those of the other tissues.

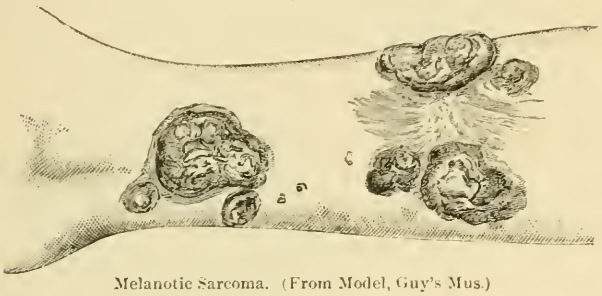
Under the microscope the characteristic polynucleated cells are seen; these are large, round, or irregular cells containing many—even ten or more—oval, well-defined nucleated nuclei floating in a clear or granular substance. They are found in masses or distributed throughout the tumor between the bundles of fibre tissue. They are diagnostic of myeloid disease. With these cells Lebert's caudate or spindle-shaped cells are also found (*vide* Fig. 43).

Melanotic sarcoma is essentially a tumor containing pigment, having its origin in a natural tissue, as in the choroid of the eye or in a mole in which pigment exists; but what it is that determines the development of these growths in tissues that have had a lifelong existence remains to be explained. The black sarcomata have, however, one peculiarity, and that is in their tendency to multiplicity. In this they are often most remarkable: the skin and subcutaneous tissues at times become studded with melanoid growths of all sizes and shades and colors. Fig. 33 is taken from a woman over whose whole body melanotic cancerous tumors were distributed, the disease having originated in a mole which I had previously excised.

Pathology.—If it were necessary to adduce a forcible illustration of the fact that a tumor when first developed in a part partakes, in a measure, of the nature and peculiarities of that part, and even when repeating itself in the lymphatic glands and internal organs still preserves the characters which it originally acquired from the seat of its primary

development, no better could be adduced than that derived from the natural history of primary and secondary melanotic growths; for a melanotic sarcoma always grows from a part which naturally contains pigment, and a mole is unquestionably its commonest seat, while pigment in some of its forms is almost always to be met with in all its secondary growths. It may be, perhaps, that the secondary glandular enlargements in their rapidity of growth outstrip the tumor from which they originally imbibed their peculiar nature; nevertheless, their true character is maintained and preserved to the end. This sarcoma, as a rule, is of the soft form and runs a very rapid course, an extreme example of melanotic sarcoma, indeed, presenting all the worst features of a cancer. In rare examples of this disease the melanotic pigment may be found in the urine (Fagge, *Path. Soc. Trans.*, 1876). It has, however, peculiarities of its own, to which attention will be subsequently directed.

Fig. 33.



Melanotic Sarcoma. (From Model, Guy's Mus.)

The *osteo* sarcoma and chondro sarcoma will receive attention in the chapter devoted to the tumors of bone (Chapter XXXII.). They are all probably only modifications of the medullary cancer affecting bone, although it may be mentioned that exceptional cases are on record where an osteoid cancer originated in some intermuscular interspaces.

2. Myxoma.—These tumors are very like the soft fibromata and certain fatty tumors. They are encapsuled, very soft and succulent, and exude a peculiar mucous juice. They are most common in the subcutaneous or mucous tissue, but are found everywhere. They are seen as parotid growths, and often mixed with fibrous or cartilaginous elements. They are doubtless often mistaken for colloid cancer. In the typical *myxoma* the tumor is less firm but more elastic than the sarcoma; its nature is far less homogeneous and presents less well-marked interlacing fasciculi of connective tissue, and from the meshes of this tissue will flow a variable stream of clear, translucent, viscid mucus. The fibres of the connective tissue are visible under the microscope, but in smaller bundles and more drawn out. Abundance of cells, also rounded, elongated, branching, and even anastomosing, together with nuclei, will be found to fill the cavities formed by the confused network of delicate fibres of which the tumor is composed. In the structure of the myxomata fat often forms an important element; glandular elements may also be found, their presence being determined by the position of the growth and the propinquity of a gland. Bone or cartilaginous elements are at times mixed with the others (Fig. 44).

Myxomata are not rare about the angle of the jaw, nose, breast, and abdomen. They are met with also in the extremities and in the eye, as well as in the delicate connective tissue of the nervous system, particularly of the brain, and also of the nerves. When attacking the brain and nerves, such growths are commonly found in the young. Virchow has named them *gliomata* (Fig. 43), the cells being of a small round or pointed form, embedded in granules, and held together by delicate fibres. In some cases the fibre element approaches the firmer kind of fibro-cellular tumors (Fig. 43).

Treatment.—Excision is the only practice that can be followed, although this operation need not be performed when the tumor is small and not progressing, especially when it occurs in aged people. Good success usually attends the practice. In the firmer varieties of myxomata a return of the tumor is not to be expected, but in the softer, where cell elements predominate, the risks of a return are great.

C. Cancerous Tumors.

What is a cancerous tumor? Of what is it composed? and, How can it be recognized? are questions which the student is constantly asking; and few are more difficult to answer with accuracy or precision.

Pathologically, a cancerous tumor is composed of cells which more or less conform to an *epithelial* type, but the student must be prepared in all—at any rate, rapidly growing—tumors to find a great variety of cell forms; and it may with truth be said that the

more the cell elements predominate in a growth, and the more they approach an epithelial type, the greater is the probability of its being malignant, and therefore cancerous, for the soft cancers, which are undoubtedly the most virulent, are made up almost entirely of cells and nuclei, only enough fibre tissue existing to bind and hold these cells together (Fig. 15).

It has been already shown how the sarcomatous tumor approaches the malignant in some of its features; and it must have been observed that these, which form the intermediate links between the innocent and malignant, structurally approach the latter in having more of the cell elements in their composition. The recurrent tumors exist as proofs of this.

But these points touch only the anatomy, and not the symptoms, of those growths; they do not assist the surgeon to ascertain before its removal whether the tumor be a cancer or not.

Symptoms.—What, then, are the external and general symptoms by which this point can be determined? And here it must be premised that in making a diagnosis the history and the progress of the disease are at least as important as the physical characters of the tumor.

If a tumor be found *infiltrating the tissues* in which it is placed, there can be little if any doubt as to its being a cancer; for no innocent growth infiltrates tissues: it only separates them.

A cancerous tumor, however, does not always infiltrate a part, although an infiltrating tumor is almost always a cancerous one; for it may appear as a distinct and isolated growth, being then, in surgical language, described as tuberous. What, therefore, are the symptoms by which a tuberous cancer may be known? What peculiarities has the tumor itself by which its nature may be recognized? Unfortunately, a negative answer must be given to this question; for although it may not be unfair to suspect the presence of a cancer when the tumor does not present any of the special appearances or symptoms which commonly characterize the innocent growths, it can only be a suspicion, as many innocent tumors are often deficient in the special symptoms which when present readily attest their true nature.

A subcutaneous tumor unconnected with the integument, with an irregular bossy outline, and of a firm, fibrous feel will, in all probability, be of a simple nature, for these are not the characters of a malignant tumor; but another with a smooth uniform external surface may be either a simple or malignant growth. If, however, any adhesion or drawing in of the integument to the surface of the growth can be detected, or any immobility of the tumor upon the parts beneath, the suspicion of its being a cancer may be entertained; for the surgeon should ever remember the tendency which the malignant tumor possesses to involve by infiltration the tissues in its neighborhood, and that this tendency does not belong to the innocent growths.

I proceed further to direct attention to another symptom which, if present, is most characteristic of cancer; and it is a secondary glandular, lymphatic enlargement. If this symptom appears, the probabilities of a tumor being cancerous become very strong, as innocent and non-malignant tumors are rarely, if ever, attended with enlarged lymphatic glands.

A distinct and isolated tumor, therefore, which does not possess any of the special characters of a simple growth, which is attended with some evidence of secondary affection or infiltration of the parts, and with which an enlargement of the lymphatic glands in its neighborhood exists, may safely be regarded as cancerous. It is, however, only in the early stages of the development of a tumor that a difficulty in diagnosis is usually felt, because, as a rule, in the long-standing and well-developed growth the diagnosis is not difficult.

The soft and so-called medullary cancer is the form which is usually met with during young life. It generally makes its appearance suddenly, and often after the receipt of some blow or injury. It grows, too, very rapidly, presenting a surface which, as a rule, is smooth and uniform or of a semi-solid and fluctuating feel, and with large full veins wandering across. It is recognized by its sudden appearance, rapid growth, and uniform surface—points very different from those which simple tumors present, innocent growths being generally slow in their development and more marked in their outline. The cases of medullary or soft cancer run their course very rapidly, and destroy life within a very short period of their development.

Hard cancers are the affections of middle age and adult life. They grow more rapidly than the innocent growths, often not requiring more than a few months to establish their true nature; they seldom put on the external appearances of a simple tumor, and never

exist long without assuming features which are more specially characteristic of cancer, the implication of neighboring tissues and secondary glandular enlargements being the chief features.

SUMMARY.—A *cancerous tumor* has, therefore, four characteristics:

1. It infiltrates the tissue it attacks and spreads by infiltrating neighboring structures.
2. It spreads to the lymphatic glands of the neighborhood through the absorbents.
3. It affects the body generally through the vascular system, thus giving rise to secondary deposits—that is to say, to the development of similar growths in the viscera or remote parts, the lungs and liver being particularly prone to its attack.
4. It is liable to recur after removal.

Cancerous Tumors have been variously described by authors. In these pages they will be treated of as the *hard*, or scirrhus; the *soft*, or encephaloid; the epithelial; the colloid and *bone* cancers, or osteoid.

All have, however, the four special peculiarities that have been already described as characterizing the disease.

Hard or scirrhous cancer is the most common; it is the hard or fibrous species denominated "carcinoma fibrosum." It is the usual form found in the female breast, and is seen in the testicle, tonsil, skin, bone, eye, rectum, or any tissue. When attacking a tissue either by infiltration (the most usual method) or deposition, it gradually encroaches upon the tissue; and when this is soft, it causes its contraction, as in the breast. The disease spreads outward, and soon takes possession of neighboring structures by infiltrating them. In this way it becomes gradually less movable, and at last fixed. No structures resist its influence, fat, skin, muscles, and bones becoming filled with cancerous elements as the disease progresses. It is said "to increase most on the side of the chief arterial supply, and in that toward which by lymphatics and veins its constituent fluids most easily filter" (Moore).

Thus the lymphatic glands become enlarged, and these in their turn may press upon nerves, causing pain, or upon veins, producing œdema. But cancers have not the power of living like innocent tumors: they are apt to degenerate and die: and thus, after a time, a cancerous tumor may soften down in its centre and burst or die as a whole and slough out, or its surface may ulcerate. But, whatever happens, the disease spreads in the neighboring parts; indeed, after the sloughing of a cancerous tumor, this spreading action in the bed from which it has been enucleated seems to be more rapid. Thus, the death of one part of a tumor is seen with the rapid increase of another part, and in this manner the disease goes on encroaching upon and infiltrating and destroying all tissues in their turn, causing death either by exhaustion, hemorrhage, or some internal complication.

In some instances of cancer the integument over or about the tumor, before ulceration occurs, becomes infiltrated with small shot-like tubercles; such a tubercle in its early stage feels to the finger like a foreign body introduced into the cutis, and as this grows it appears as a distinct skin tubercle. No clinical symptom is more characteristic of cancer than the presence of these skin tubercles.

In other instances the whole integument becomes œdematous and brawny—in fact, infiltrated with cancerous elements—this state betokening the most rapid form of cancer. This brawny condition of integument commonly follows venous obstruction from glandular enlargement, but at times it takes place before any such complication. In rarer cases the cancer withers, "atrophic cancer," the disease slowly progressing to a point and then disappearing by a gradual process. Thus, cancerous tubercles will appear and disappear; cancerous nodules will form and fall off by the contraction of their own fibres. In this way cancer may become cured or so stationary as not to interfere with life. I have had a case under observation in which the disease existed for twenty-three years and seemed still local. I have recorded another, in which the disease lasted twelve years, appearing and crumbling away at times during that period almost to a perfect cure. Cancers display a very variable degree of growing or existing power, and there does not seem to be any condition of the patient or of the tumor which either favors or disfavors these properties.

Some have an apparent vigor of increase that is remarkable, whilst others show no such tendency. In many cases a tumor that has been quiescent for a long period will suddenly increase actively.

The same thing may be said as regards the *cancerous ulcer*. In the atrophic form this may be merely a superficial loss of substance on the surface of the tumor, which may be covered with a scab or present a glazed or a very slightly discharging surface. In other cases the ulcer will show an irregular surface with an elevated everted edge infiltrated with new tissue (Fig. 34).

When a cavity exists, formed by the softening down of the centre of the tumor or the enucleation of dead tissue, the irregular outline of the cavity, the fetid semi-purulent sanious discharge, as well as the ragged and infiltrated edge of the wound, are characteristic signs of its cancerous nature.

In such cases a cachexia becomes visible, a pale, bloodless, haggard look of sorrow and suffering, brought on by pain, sleeplessness, and exhausting discharges.

Pain in the development of a cancer is a very variable symptom. In primary growths it is rarely severe unless some nerve trunk be pressed upon or the tumor is bound down by a tense fascia or is developed within a bone. Under all these circumstances the pain is constant, of an "aching or of a so-called rheumatic kind." In others it is usually compared to an occasional dart of pain through the part.

As a sign of secondary deposits pain, however, is a valuable symptom, neuralgic pain following the course of a nerve being enough to excite fear of some deep-seated secondary growth. Than this no more valuable or reliable clinical symptom exists.

The *section* of a scirrhous cancer is generally attended with a grating sensation, the parts cutting crisply; it presents a *concave surface*, and yields, on scraping, a milky juice. The tumor has no defined margin, the diseased and healthy tissues, as it were, dipping into each other. The surface of the cut portion may be vascular or bloodless, and has a bluish-gray or streaked yellow aspect, according to the amount of cell or fibre elements entering into its formation or to its progress toward degeneration, the yellow spots being indicative of degeneration. Occasionally cysts, or rather cavities, containing serum, blood, or broken-down tissues, are found in the tumor, and at others creamy, saponified masses of degenerated tissues.

The microscopical appearances of carcinomata are well shown in Fig. 45.

Medullary cancer, like the scirrhous, is either *infiltrating* or *tuberous*, and possesses in a marked degree all the cancerous peculiarities. It is doubtless only a form of cancer, and not distinct from the scirrhous varieties, because both often coexist, and the growths which are secondary to the hardest primary cancer are generally the soft variety. Medullary cancer is, however, the special form that appears as a congenital tumor and which attacks children and young adults, and may be called "the cancer of young life." These growths form very rapidly and run their course far more quickly than the harder kind. They increase so fast that they push away the tissues with which they are surrounded more like the innocent tumors which separate them; their capsules prevent that general infiltration of the parts which is observed in the infiltrating form. It is found, although rarely, in the breast, yet more frequently in the intercellular tissue and about the periosteum and bones. It is the usual form attacking the eye, uterus, tonsil, testis, and ovary, the bones and cavities of the head and face appearing peculiarly liable to its inroads.

These soft cancers usually appear as deep-seated swellings, and when not bound down by fascia or connected with bone are rarely painful; but when so situated, a gnawing pain or ache is a frequent concomitant. As they progress and become more visible they may present either a nodular lobulated or a smooth and uniform aspect, but in either case the integument covering in the growth will be traversed by many very large and dilated veins; while in some instances the growth has a bluish congested aspect, as if filled with venous blood. These tumors are often so vascular as to pulsate, and thus simulate an aneurism. Such a symptom, however, is mostly observed in those connected with bone.

To the touch the swelling feels soft and fluctuating, often giving the idea of fluid; and should the surgeon, to satisfy himself upon this point, puncture the tumor with an exploring-needle, blood will freely escape, and with it some creamy tissue, which under the microscope will be seen to be made up of cells and nuclei.

When these soft cancers have burst through their fascial envelopes, they grow more rapidly; and when they have made their way through the skin, they, as it were, pulp out, and project much as a hernia cerebri does after compound fracture of the skull. The soft succulent granulations and blood-infiltrated tissues that project suggested to Mr. Hay of Leeds the term "fungus hæmatodes." When a soft cancer is filled with blood, it is known as a "hæmatoid variety."

When they appear in the parotid region, they usually, if not always, produce paralysis of the facial nerve—a clinical symptom, I think I may say, never found in the ordinary innocent parotid tumor; so that when present this symptom is of value. As a rule, however, this soft cancer surrounds nerves and vessels without materially pressing upon them, large vessels and nerves being often found passing completely through their substance.

The section of a soft differs from that of a hard cancer as the "infiltrating" differs

from the "tuberous" (compare Figs. 446 and 447), and differs also very materially in itself at different times. It may be firm or nearly fluid, white and creamy, or red and blood stained. It may be soft from inflammatory action or degenerating from natural decay.

Under all circumstances, however, it will be divided into lobules, fibrous septa or fibrous envelopes separating these lobules from one another as the fibrous capsule of the parent growth separated it from the other tissues.

The material composing these cancers, says Paget, "is a peculiar, soft, close-textured substance having very little toughness, easily crushed and spread out by compression with the fingers. It is very often truly brainlike, most like fœtal brain, or like adult brain, partially decomposed or crushed. Many specimens are, however, much softer than brain, and many, though of nearly the consistence of brain, are unlike it, being grumous, pulpy, shreddy, or spongy, like a placenta with fine soft filaments. Very few have a distinct appearance of fibrous or other regular structure."

These tumors, when pressed or scraped, yield abundant "cancer juice:" and such juice is generally diffusible in water. No better rough test, says Paget, exists for the diagnosis of medullary cancer than this. The stroma of this cancer element is filamentous and more or less condensed; it is also generally very vascular. The cell element always predominates, but the cells in no way differ in character from those found in the fibrous or scirrhous form. They are, however, less closely packed together, and seem to be suspended in the juices of the growth or enclosed within its delicate connective tissue (Fig. 45).

Epithelioma and epithelial cancer are terms given to a form of cutaneous cancer from its similarity in structure to the epithelial elements of the natural skin, these elements assuming in some cases, as in the cancers of the face, the smaller type of the epithelial elements, and in others, as in the lip, the larger.

In one case the disease may appear as a superficial thickening of the part affected, and in another as a nodular or warty growth. All these growths, however, have a tendency to break down; and this tendency varies in each case. In some it is very slight, whilst in others it is so rapid that the degenerative changes keep such even pace with the formative that the disease assumes from its very origin the appearance of an ulcer, when it is known as the "rodent ulcer" (Fig. 35). In the chain of malignancy epithelial cancers are linked to the recurrent tumors, for they have both a tendency to return in a part after their removal and to affect the system through the lymphatics; while in exceptional instances they may be found in the internal organs.

These tumors affect the skin or mucous membrane, and never originate in any other tissue. They possess this feature also in common with the more malignant cancers, in that they have a constant tendency to infiltrate the parts with which they come in contact, and do not, as innocent tumors, simply separate them. They are the common forms of cancer found in the lip, tongue, œsophagus, rectum, scrotum, penis, clitoris, os uteri, vulva, etc., and may be described as the cancer of the skin, while in sweeps it is known as the "chimney-sweep's cancer." Epithelial cancer is essentially an infiltrating disease: it is not, as the sebaceous, fatty, fibrocellular, or fibrous tumor, a distinct growth developed in the tissues and separating them, but it is from its very beginning an *infiltration*. It begins, as a rule, in a wart or tubercle, which grows: it may fungate, crack, fissure, or ulcerate; and when this latter stage has been arrived at, its true character will at once be observed by the careful examiner, as the integument forming its base and margin will be evidently infiltrated with the cancerous material, presenting the well-known raised, indurated, and everted edges (Fig. 34). These appearances form a marked contrast to the condition of integument which is met with where an innocent growth has ulcerated through or ruptured by overdistension its cutaneous covering.

FIG. 34.

Cancer of stump of Two Years' Standing. (From a man æt. 58.)

As a local disease epithelioma may progress slowly for years and cause little pain, inconvenience, or injurious effects, and five, six, eight, or even fifteen, years have elapsed in some of the cases that have been under my notice before advice was sought: it may, moreover, continue for many years before it affects a patient in other ways than as a local disease. On the other hand, when it once begins to spread, it may do so rapidly;

and after removal it may return at once, not only in the part, but in the lymphatics of the district, and even in the internal organs. When it spreads locally, it may as a cancer infiltrate and invade every tissue which it reaches. I have seen it more than once originate in skin and end in a total destruction of a bone (*vide Guy's Hosp. Rep.*, 1875).

Epithelial cancer is made up of cells which differ but little from those of ordinary epithelium, though they are grouped very differently; they infiltrate the tissues in which they are placed or are clustered together in masses, these masses being described as "nests" (Fig. 45).

The surface of an epithelial cancer may be dry and warty or ulcerating; when ulcerating, it will be, like all cancerous sores, irregular, and will discharge a thin or a creamy fluid. The edge will always be thick and elevated, like a wall of new tissue built up between the healthy and diseased structures (Fig. 34). When the disease spreads, it will invade and infiltrate every tissue, forming deep excavated sores. It may involve the lymphatic glands, like any other cancer; and these glands may soften down and give rise to a cancerous abscess or an open sore. It usually destroys life from local causes, and not from secondary infiltration of the viscera, such a consequence being quite exceptional.

Treatment of Epithelial Cancer.—These cancers should always be removed; and the sooner this is accomplished, the better the prospects of a cure or of a long reprieve, for if any cancer has a local origin the epithelial has, and if it be removed before any glandular enlargement has taken place the prospects of a good result are great. Sibley (*Med.-Chir. Trans.*, vol. xliii.) made out from the Middlesex Hospital records that epithelial cancers, on the average, destroyed life in fifty-three months, while scirrhous lasted but thirty-two. When removed by the knife, care should be taken to cut well free of the disease; for it is not unusual in this, as in all cancers, to find the tissues around the tumor sparsely infiltrated with cancerous elements which if left would cause a return of the tumor. The same advice is applicable when causties are employed.

In many examples of this form of the disease the removal by the galvanic cautery is by far the best method of treatment we possess, either as a cautery applied to the surface or as a wire écraseur applied around the base.

Rodent ulcers are forms of epithelial cancers. Dr. J. C. Warren of Boston, United States, in an able essay upon this disease, asserts that the cells of the rodent ulcer differ from those found in the epithelial by being smaller. They are local cancerous affections and expend their force in destroying every tissue attacked, but they do not spread by means of the lymphatics or by secondary growths. They usually begin on some part of the face, head, or other locality as a dry wart, which after it has shed many skins begins to ulcerate. The ulcer then spreads slowly and regularly, with a border of new tissue as a wall, to separate it from the healthy parts; outside the border the parts are soft and natural, inside they are generally smooth, as an indolent sore, devoid of granulations, and glazed (Fig. 35). There is little discharge from these sores when superficial; but when they are extensive and have dipped down deeply into other tissues, this is not the case; and when they inflame, they discharge a fetid ichorous pus. They seem to attack healthy as well as feeble subjects, and have little effect upon the general health until they touch vital parts. They appear after middle age and are of extremely slow growth; they are to be treated locally by their destruction, cautery, escharotics, or scalpel being used, as seems most applicable. In local sores the knife, when it can be used, is probably the best instrument, but in others the galvanic cautery is unrivalled. In lieu of this the benzoline cautery may be used, and next to this escharotics; "the caustic burns through the entire depth of the solid disease, and upon the casting of the subsequent slough cicatrization is rapidly completed" (Moore). Chloride of zinc, potassa fusa,

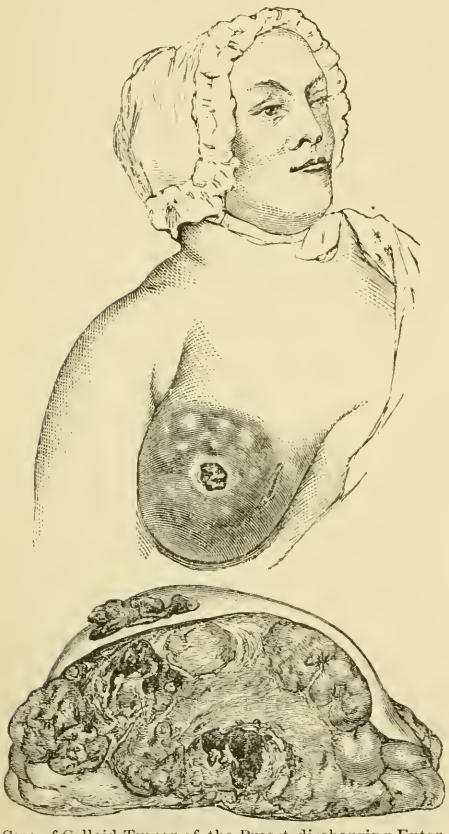
Fig. 35.

Rodent Cancer of the Face. (From an original drawing of Sir Charles Bell's, contained in the museum of the Middlesex Hospital, and recognized by Messrs. Shaw and Campbell de Morgan. It was introduced to my notice by my friend Mr. Henry Morris of the Middlesex Hospital, and kindly placed at my disposal by the museum committee of that institution.)

Vienna paste, or acid nitrate mercury may be applied; the zinc, rubbed down in a warm mortar with equal parts of fresh plaster of Paris, is probably the best, because it destroys and dries the tissues.

Colloid cancer is hardly recognized as a special disease, for the term "colloid" is applied to tumors made up of intercellular spaces of variable sizes filled with a clear glairy fluid like glue, which contains abundance of granules and large nucleated cells (Fig. 45). The clinical history of some of these growths is that of an innocent tumor, whilst in others it is that of a cancerous nature. Colloid tumors are found in the breast, parotid region, ovary, rectum, and intestinal canal, it being known in this last region as the alveolar or gelatiniform cancer. Their true nature is not yet fully understood.

FIG. 36.



Case of Colloid Tumor of the Breast discharging Externally, in a Woman æt. 65, with Section of the same.

In the case Fig. 36 the patient was sixty-five years of age and the disease had been growing for two years. The tumor occupied the outer portion of the gland and had burst the skin covering it in. The colloid growth projected through the opening, the margins of which, however, were not infiltrated with disease. There were no enlarged axillary glands. This patient was eight years subsequently readmitted into Guy's under my care, in May, 1881, when she was seventy-three, with a true carcinomatous affection of the nipple of the opposite breast which had been recognized for six months. The nipple was retracted and involved in an indurated mass of disease about the size of a walnut. The lymphatic glands were healthy, as was the scar of the old operation.

Villous growths may be cancerous as well as benign. When made up of cell elements, their cancerous nature is to be suspected; but the fact is only to be discerned by the clinical career. The nature of villous and colloid disease has been very ably discussed by Mr. Sibley in the *Med.-Chir. Trans.*, vol. xxxix., and *Path. Trans.*, vols. vii., viii., and ix.

THE CAUSES OF CANCER.

These are most obscure, but the most constant cause is, without doubt, persistent local irritation. *Local injury* also appears to have a very marked influence in determining the seat of a cancer; many cases supporting this view have fallen under my observation, and one of such occurred to me recently in the case of a boy æt. 18, who, after an injury to his right spermatic cord, in a few weeks became the subject of a pelvic tumor, which rapidly grew, and eventually destroyed life by obstructing the rectum as well as the ureters. After death the tumor was found to have been cancerous, having originated apparently in the right or injured cord, spreading downward along the vas deferens to the base of the bladder, and subsequently ascending from the pelvis, above the level of the umbilicus.

Hereditary influence has always been considered as a very decided cause; still, in how small a proportion of cases can any such be found! Sir J. Paget traced it in one out of every three; Mr. Sibley, in one out of every nine; and in 222 consecutive cases of my own it was traceable only in one out of every ten instances. In many other affections, even the most innocent, as large a proportion might be found. In fatty tumors and in deformities all surgeons recognize the frequency of an hereditary history. Indeed, looking at cancer as one of many diseases, there is no reason for regarding it as more heredi-

tary than any other; and I am inclined to agree with Mr. de Morgan when he said "that all that could be said with regard to the constitutional nature of cancer applied equally to the constitutional nature of any, the smallest, growth that can be found in the body."

The death-rate of cancer, according to the registrar-general's report, is one in 2083 cases, but—and from the same authority—cancer is become more common. Mr. W. H. Cripps shows in a paper in the *St. Barth Hosp. Rep.*, 1878, that the death-rate from cancer in the community in subjects over 20 is about one in every 29.1 cases.

Striking examples of the hereditary nature of cancer are met with in practice, but they are not more striking than, if so much so as, the hereditariness of growths of a simple kind. Sir J. Paget has pointed out, however, that when a local disease or deformity is inherited, it passes from progenitor to offspring in the same tissue, if not in exactly the same place; whereas, when a cancer is hereditary, it may break out anywhere. "The cancer of the breast in the parent is marked as cancer of the lip in the offspring; the cancer of the cheek in the parent becomes cancer of the bone in the child. There is in these cases absolutely no relation at all of place or texture."

Cancer is a disease of adult life, although it may attack a fœtus in utero or an infant soon after birth (*Guy's Hosp. Rep.*, 1875). In a general way, it is most prone to attack an organ that has passed through the active period of its existence and is degenerating, as in the breast or uterus. Sir J. Paget describes it as being "essentially a disease of degeneracy," and asserts "that it increases in frequency in proportion to the number of persons living as age goes on." When it does affect an organ in the full vigor of its functional activity, it partakes of that activity and runs its course with marvellous rapidity.

Cancer appears to be in its origin a local disease, and to become general either by the influence of the juices of the primary tumor exercising an impregnative spermatic influence (Simon) upon other parts or by dissemination of its elements. This dissemination at first may radiate from its local source, and at a later period may become general through the fluids of the body. The secondary growths will partake largely of the characters of the primary; thus the osteoid cancer will propagate osteoid, and the melanotic melanosis, each cancerous growth, like a parasite, growing at the expense of the tissue in which it lies. Moore, in his work on the *Antecedents of Cancer*, and De Morgan more recently, have, I believe, established this fact. From a clinical point of view this is, without doubt, of very practical significance; for surgeons now admit that the earlier a cancerous tumor is removed the better are the prospects of a cure, or, at least, of a long immunity from the disease.

Treatment of Cancer.

The *general treatment* of cancer resolves itself into the improvement of the general nutrition of the body by hygienic means, good nutritious diet, and tonic medicines. No medicine has any special influence on the disease.

The *local treatment* may be summed up in the word "removal;" for all cancers should, if practicable, be taken away as soon as their true nature has been established. In the early stage of a cancerous tumor, before the diagnosis has been made out, it should be protected from external injury and from all irritating causes. No rough manipulation should be allowed, nor any movement of the muscles that surround or influence it. Warm or hot applications should be avoided, since they appear to encourage its growth. The most acute cancer of the breast I ever saw was one that originated as a chronic infiltration, and was made active by the application of hot fig poultices for a week. The gland itself, and the skin over it to the limit of the application, became infiltrated to an extreme degree with cancer, which rapidly broke down and destroyed life.

Moore used to think highly of the local application of the iodide of lead and opium ointment applied on lint to the tumor, and he believed it had some influence in diminishing and retarding its growth. Some have faith in iodine as a local application, but I must admit that I have never been able to discover that any of these or other applications had the slightest influence in checking the progress of a cancer, and have consequently discarded them. When pain is present, the belladonna extract rubbed down with glycerine into a fluid the consistence of treacle, or of the extract of opium similarly diluted, seems to be a valuable application. An opium or belladonna plaster spread on leather gives comfort and protects the part. The best protective application, however, is cotton-wool.

Excision.—When the diagnosis is established, the tumor should be removed; and the best method, doubtless, is that of excision, delay being only justifiable when the gen-

eral condition of the patient forbids the attempt. To delay is only to increase the risk of a local dissemination of the cancerous elements, and thus diminish the prospects of a successful result; to give time for the lymphatic glands to become enlarged, when removal of the primary growth becomes of less value; and to increase the chance of some internal or remote organs becoming involved, when operative interference is futile.

Free Removal.—In removing a cancerous tumor the surgeon should not be too sparing of surrounding tissue; but when it is encapsuled, there is no necessity for doing more than enucleating the mass. When it infiltrates an organ, the only correct treatment is its removal; and in removing it care should be taken to cut away all skin that is in any way adherent to its surface, with as much of the surrounding fat as circumstances will allow.

When the tumor has been removed, all surrounding parts should be carefully examined, because it is not uncommon to find small cancerous tubercles in the connective tissue, fascia, or muscular sheaths, which if passed by unheeded would soon increase and give rise to a recurrent growth. It is from these points, indeed, that such recurrent growths probably often arise, and these, by care and observation, the surgeon may often prevent. De Morgan, after excision of a cancerous tumor, washed the wound with a solution of chloride of zinc twenty grains to an ounce, in order to destroy the cancer germs. The surgeon, too, had better remove all skin and allow the wound to granulate up than save integument which is of doubtful integrity for the sake of making an apparently more complete operation. When lymphatic glands are enlarged, they should be removed at the time of operation: and they should be enucleated by the fingers or handle of the scalpel rather than be excised. Their capsules ought to be divided and the glands turned out.

Cancerous tumors of the tongue, penis, clitoris, labium, neck of the uterus, etc., may be removed by the wire or chain écraseur, either with or without the cautery; but this part of the subject will receive attention in other pages.

Removal by Caustics.—When a cancerous tumor cannot be excised or the cutting operation is rejected, it may be removed by caustics; but such a method is more painful and slower than excision, and not so successful. When employed as a substitute for it, it is, like all substitutes, only second-best; yet it is, however, often applicable where excision is not. The French surgeons do this by inserting around and into the tumor thin, conical, flat wedges of chloride of zinc made into a hard mass with flour or plaster of Paris, holes being made into the tissue by the scalpel for the introduction of these flèches. Maisonneuve is the chief practitioner of this school. These "caustic arrows" of M. Maisonneuve are composed of wedge-shaped pieces cut from a thin cake of paste made by mixing one part of the chloride of zinc and three parts of flour with as much water as may be found necessary. These pieces or arrows are dried, and may be kept in a bottle for a long time without injury.

Strong Acids and Caustic Paste.—In England this plan finds little favor. The following method is more general: In a tumor that is not ulcerated let the skin be destroyed by the application of some strong sulphuric or nitric acid, and in this slough let one or more incisions be made, and into these incisions let a paste of chloride of zinc and flour mixed with the extracts of the *Sanguinaria Canadensis* and stramonium be introduced, fresh incisions being made through the thickness of the slough thus formed every other day and fresh paste inserted. By this means the whole tumor may be destroyed or enucleated. The paste is a modification of that introduced into London by Dr. Fell of the United States, and is, without doubt, the best working caustic paste we possess. The following is the mode of its preparation: Boil down to a liquid extract some decoction of the *Sanguinaria Canadensis*, and with an ounce of the extract dissolve a similar quantity of the chloride of zinc. Mix this with two ounces of the extract of stramonium, and the soft paste is ready for use.

Canquoin's paste is composed of chloride of zinc and flour in equal parts, a few drops of water being necessary to make it into a paste. A second form is probably better: Chloride of zinc, one part; muriate of antimony, one part; flour, one part and a half; water, a few drops. This paste is of the consistence of soft wax. At the Middlesex Hospital they use a paste made by mixing chloride of zinc and boiled starch with laudanum till it reaches the consistence of honey.

When the tumor is ulcerating or open, the paste may be applied directly to the part and fastened on by cotton-wool and strapping; the thickness of half an inch applied for twelve hours usually produces a slough an inch deep.

Some prefer a solution of chloride of zinc alone inserted on cotton-wool. M. Rivallié uses nitric acid applied on lint or asbestos; Velpeau, sulphuric acid on saffron. By some

the Vienna paste is preferred. Arsenic as a caustic has had its day, and is dangerous and less effective than zinc.

For cutaneous epithelial cancer the caustic treatment is the best. The chloride of zinc made into a paste with flour or with sanguinaria may be used, if preferred. The potassa fusa is likewise a useful form. When the galvanic or thermo-cautery can be obtained, epithelial skin cancer may be readily destroyed. I have burnt down many such affecting the nose, cheek, eyelid, scalp, hand, arm, lip, and other parts. By it large surface of diseased tissue may be completely carbonized and a healthy surface produced after the removal of the eschar. The operation should be performed with the aid of chloroform and the whole thickness and edges of the diseased tissue destroyed. The after-pain is very slight, the cautery destroying all nerve sensibility. It is by far the best mode we possess of dealing with skin cancer, is more rapid in its action and certain in its result, besides being far less painful. When the disease extends, it may be removed with the scalpel and the base of the sore cauterized. No more efficient mode of removing a skin cancer is within our reach.

The treatment of tumors by injection of fluids into their substance, as originally suggested by Sir J. Simpson, and more recently practised by Dr. Broadbent, has in it the elements of a successful plan, but has not yet been brought to any available state of perfection. Fatty tumors may be destroyed by the introduction into their substance of a few drops of deliquescent chloride of zinc, but cancerous tumors do not appear amenable to a like remedy. Dr. Broadbent believes that he has succeeded by injecting a liquid composed of one part of acetic acid and three of water, while Messrs. Moore and De Morgan assert that they have each succeeded by these means in obtaining gradual diminution of cancerous growths. I tried the plan in twenty cases when it was first introduced, but never found any good result ensue. It was often very painful, and many patients refused to have it repeated, although they asked for the excision of the growth. More recently the injection of twenty drops of a solution of bromine dissolved in spirit, ♏v to a ℥j, has had its advocates.

The treatment by pressure is of no practical utility.

By way of summary it may be stated:

I. That cancerous tumors should be excised when practicable; and the sooner the operation is performed after the diagnosis is clear, the better; that with the primary growth all lymphatic glands that are involved should be removed likewise.

II. Open cancerous tumors, as a rule, should be treated by caustics, the best being those which contain chloride of zinc.

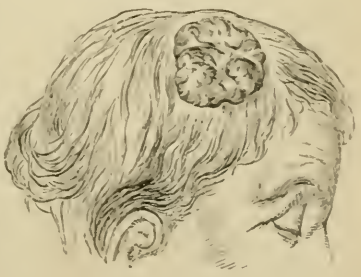
III. For skin cancers caustics are, as a rule, the most available, although excision in some instances, as in the lip, is to be preferred. The galvanic or thermo-cautery, however, should be employed when possible, it being the most rapid and efficient destructive agent we possess.

D. Granulation Tumors

Include all composed of granulation tissue and have their origin in inflammation, whether of a specific or simple kind; the fungating and follicular tumor and the pedunculated umbilical growths are its best examples, but it occurs in many other shapes.

Fungating and Follicular Tumors.—In neglected examples of sebaceous cyst the contents of the tumor may soften down and, suppurating, escape externally by ulceration. From the inner surface of the evacuated cyst a new growth may spring up, which, when forming an irregular, fungating, bleeding surface, may at times put on an appearance which has been mistaken for cancer. On examining the edges of the wound, however, this mistake can scarcely be long entertained, as it will be at once observed that the edges of the wound are healthy, and not infiltrated with new matter, as would be the case in a cancer (Fig. 37). This fungating growth is really composed of exuberant granulations from the cyst itself. Abernethy recognized this when he said, "I have also seen, after the bursting of an encysted tumor, the surrounding parts indurate and throw out a fungus, forming a disease appearing like cancer, and which could not be cured." And "it is no uncommon circumstance to meet with wens that have burst spontaneously and have thrown out a fungus which, like a fungous

Fig. 37.



Fungating Follicular Tumor.

body, prevents the surrounding integument from healing." The best account of the affection is by Mr. Cock (*Guy's Rep.*, 1852).

TREATMENT.—There is but one form of treatment which is applicable to these tumors, and that is their excision, care being observed to cut away the whole of the diseased tissue.

Granulation tumors probably include the keloid.

E. CYSTS.

These are developed in many ways:

1. Some are possibly new growths or largely developed cells having an independent life and being capable of secreting their own contents or producing solid growths—"autogenous cysts," as Sir J. Paget calls them.

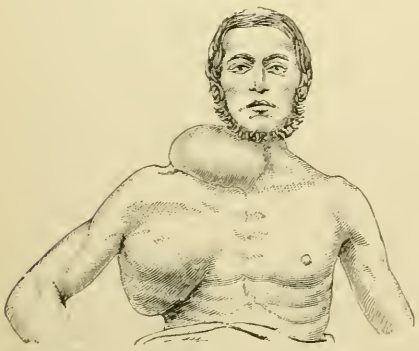
2. Some are formed in an accidental way by the simple effusion of fluid into the spaces of connective or other tissues, the walls of these *false cysts* gradually consolidating, as is commonly seen in bursæ and in ordinary tumors.

3. Others, again, are produced mechanically by the dilatation of occluded ducts or natural gland orifices, the cyst enlarging by the secretion of the ducts or gland contents. Of these the mucous cysts of the mouth and vagina, the sebaceous cysts of the skin, and the milk cysts of the breast are the best examples. Virchow calls these "cysts by retention."

In many cases, however, it is impossible to ascertain how the cysts are formed. Some are parasitic.

Serous cysts are most commonly found connected with one of the vascular glands of the body, as the kidney, ovary, thyroid, or breast; but they are not rare in the connective tissue, and are found even in bones. When seen in the neck, they are described as "hydroceles of the neck." Some of these are congenital, but the majority occur later in life. They appear as single or multilocular cysts made up of thin membranous walls lined with pavement epithelium. Like a serous membrane, they contain a limpid, watery, or tenacious, highly albuminous fluid more or less stained with blood, occasionally holding cholesterine in suspension. These cysts are found in the neck anywhere between the lower jaw and clavicle, beneath which they at times pass (Fig. 38); they are usually deeply seated, and occasionally superficial; they give annoyance only from their size, and are painless; when inflamed, they may suppurate. They are recognizable by their globular cystic form, soft fluctuating feel, and painless increase.

FIG. 38.



Serous Cyst of the Neck (Birkett's case).

These cysts are not to be confounded with those of the *thyroid gland*, which are far more common, and at times attain a large size, growing as quietly and painlessly as do the cervical. Usually, however, they have thicker walls, are more tense, and are commonly multiple; moreover, they move up and down with the gland on deglutition. Their contents are more viscid and frequently mixed with blood in variable proportions; indeed, some of these thyroid cysts are *blood cysts*, which when tapped would go on bleeding, if allowed, even to the death of the patient. I have recorded such a case (*Guy's Reports*, 1864). It is probable, as Sir J. Paget has suggested, that many of the cervical cysts are thyroid in their origin, springing from some outlying portion of the gland.

Cysts are also found over the thyroid cartilage, but these mostly contain grumous blood and rarely grow larger than half a walnut. In a case under my own observation a cyst completely covered the thyroid cartilage, and was lost on either side in the deep tissues of the neck. It existed in an adult man as a soft fluctuating swelling, and had been growing for some years as a painless formation.

Cysts which are possibly bursal are likewise found in connection with the hyoid bone.

TREATMENT.—Cervical cysts had better be left alone, unless from their size they require surgical treatment, because there is always danger in dealing with any deep-seated cyst in this region from the liability of subsequent diffused inflammation of the cellular tissues of the neck. I lost a patient some years ago from this cause, after simply tapping the cyst.

When surgical treatment is called for, *palliative* means had better be primarily adopted. This treatment consists in merely drawing off the contents of the cyst by means of a trocar and canula or the "aspirator." Should the fluid re-collect rapidly, the operation may be repeated. In performing this operation the surgeon, to guard against puncturing any of the superficial veins or deep vessels, should recall their position before puncturing.

Should these measures fail even after several repetitions, the best practice is to introduce into the cavity of the cyst a drainage-tube. When the tapping has induced some suppurative action, the opening may be enlarged and the tube inserted; but when the cyst is large, it is well to pass the tube completely through it. This may readily be done by means of a long trocar and canula, such as that employed for puncturing the bladder per rectum, the pilot trocar being introduced into the cyst after it has been opened and made to traverse the cyst to its most dependent point, possibly beneath the sterno-mastoid muscle. The pilot trocar should then be removed, the drainage-tube passed through the canula, and the canula taken away, the two ends of the tubing being fastened together to prevent its slipping out. I have treated many cases of deep cervical cysts in this manner with success. The great point to attend to is the free escape of pus and the cyst contents; if air gets in, let the opening be free enough for it to pass out. Should fetor appear, the cyst should be washed out daily with iodine or chloride-of-zinc lotion, Condy's fluid, or some other disinfectant. As the cyst contracts the tube may be removed, but so long as any cavity remains it should be left. The passage of a seton through the cyst is another method which may be adopted, and this is probably more suitable for small than for large cysts. Injecting the cyst with iodine is a third plan which has proved successful, though it is as dangerous as any other and not more successful. Extirpation of any large cervical cyst is a mode of treatment which should not be entertained, since it is fraught with danger and difficulties.

Thyroid cysts and their treatment will receive attention in another chapter.

The student should remember that nævi, when they degenerate, commonly show cysts in their structure (Fig. 161); these are, however, usually clustered together in a cutaneous or subcutaneous group. When they appear in the neck, they might be mistaken for one or other of the cysts already alluded to. This mistake will be prevented by remembering the fact that they do occur and by the history of the case.

Congenital cystic hygroma or tumor is a peculiar affection, the nature of which is not clear. It may appear in the neck, its most common seat, or elsewhere, as a cystic swelling or as a more or less compact solid growth, the cystic element varying in each case. It is always deeply placed beneath the fascia and dips down beneath muscles, tendons, and vessels. The skin over the tumor is, as a rule, healthy and movable; but in some cases, from the lobulated nature of the tumor, the skin is dimpled as in a lipoma. From its appearance and position it may simulate many other affections, such as nævus or spina bifida; but pressure upon it has no influence in lessening its size.

The disease has a tendency to disappear naturally, though at times it may grow rapidly. In some cases it inflames and then shrinks.

When treatment is absolutely called for, that by setons, as suggested by Mr. Thomas Smith (*St. Barth. Hosp. Rep.*, 1866), is the best. The knife should be employed in exceptional cases alone. The value of injection of iodine or Morton's iodo-glycerine solution has yet to be tested.

Mucous cysts are found wherever mucous glands exist, and are caused by some obstruction to the escape of the gland contents. They contain highly tenacious mucus-like liquid albumen. They appear on the mucous membrane of the lips as *labial cysts*, and are small, tense, globular, painless swellings. They are found within the cheeks, upon the tongue and gum, particularly of the upper jaw and antrum, and very commonly beneath the tongue, as *sublingual mucous cysts*, when they have been described as cases of "*ranula*." Such cysts, however, are now known to be due to obstruction of the ducts of Rivini's mucous glands, and are not necessarily connected with the salivary organs (Fig. 214). These cysts may develop about the larynx and cause obstruction, and they have been found in the œsophagus. As *labial* and *vaginal mucous cysts* they appear as tense, globular tumors beneath the mucous membrane of the parts. I have seen them as large as an orange. These cysts generally contain thick, ropy, mucoid fluid of a colorless or slightly yellow tint. Occasionally the fluid is mixed with blood in different proportions. I have seen them contain black, milky, or coffee-ground fluid. Sometimes they inflame and suppurate and run on into abscesses.

TREATMENT.—Small labial cysts may often, on dividing the mucous membrane over

them, be turned out as a whole; but the sublingual and larger vaginal cysts, as a rule, cannot be thus treated. A free opening into them or the removal of their external wall, and the introduction into the cavity of a plug of lint soaked in iodine to excite suppuration, may at times suffice to bring about a cure, but not always. In the so-called ranula it may be tried before other practice is attempted. In the sublingual, labial, and vaginal cysts I have for some years been in the habit of seizing the upper surface of the cyst with a pair of forceps or tenaculum and cutting it off with scissors, thus freely exposing the deeper wall. In the sublingual this practice is, as a rule, successful without further treatment; but in the labial and vaginal cysts I have, in addition, generally destroyed them by the application of some caustic, such as nitrate of silver or carbolic acid, to the exposed surface, after which the wound will granulate healthily. When these cysts can be excised, the operation can be performed.

The mucous cysts of the antrum and upper jaw will be described amongst the tumors of the jaw.

Cutaneous sebaceous cysts, as they come under the notice of the surgeon, appear as "*congenital*" and "*acquired*" tumors. They are analogous to the mucous cysts, the glands of the tissue being in both instances at fault. Some are doubtless caused, as first described by Sir A. Cooper, by the obstruction to the orifice of the sebaceous glands of the skin, for this occluded orifice may often be seen as a small, depressed, black umbilicated spot upon the tumor; the contents of the cyst may often be squeezed through this orifice, or into it a probe may be passed. In a larger proportion of cases, on making an attempt to raise the skin from the tumor, a dimple or evidence of connection between the two will be visible, thereby revealing its nature. But in other cases no such obstructed duct, or even cutaneous depression, can be observed; and, although the tumor may be developed within the integument, it is probably a new formation, an adenoid or glandular skin tumor.

The **congenital** sebaceous tumors differ from those usually met with in the adult, or the acquired form, in that they are more deeply placed and mostly lying beneath the fascia of the part, occasionally beneath the muscles; they are rarely cutaneous. They are more common about the orbit and brow than any other part, the external angle of the eye being their favorite seat. They appear as small, hard, semiglobular masses deeply placed, and are often, indeed, upon the bone. Cases, too, are on record in which by their presence they have produced perforation by absorption of the bone. In the ear this result is not rare. These cysts are thin-walled and often contain liquid secretion, sometimes of a pearly whiteness and not rarely mixed with hair. I turned a complete ball of hair out of such a cyst on one occasion, though usually the hairs are fine like eyelashes and are mixed with the sebaceous matter. The contents of these congenital cysts are rarely offensive.

The **acquired** sebaceous cysts may be found on any part of the body that is covered with skin. They are more common on the head and face than elsewhere, two-thirds of all cases occurring in these regions. When on the scalp, they are known as "*wens*" (Fig. 39). They are always surrounded by a cyst-wall composed of fibrous tissue more or less dense, and which can always be seen after these tumors have been enucleated from their beds. In "wens," however, there is a marked peculiarity which demands some notice. "The chief peculiarity consists in a thick, dense, horny capsule which is closely in contact with the fibrous envelope of the original gland. This horny capsule was formerly regarded as the cyst-wall altered by pressure, until Sir Prescott Hewett demonstrated its true relations and anatomical structure in his lecture at the College of Surgeons. It is now clearly proved that when one of these sebaceous tumors is squeezed out after the division of the skin, the fibrous cyst remains behind. This cyst can be afterward excised, and its structure is identical with that of all the others. But the construction of the horny capsule requires explanation. If carefully examined, it is found to consist of epithelium, layer upon layer, mixed up with sebaceous matter. Sometimes a solid mass of epithelium is formed; in other instances a cavity exists in the centre, filled with soft sebaceous secretion. This capsule, then, seems to be a production of the epithelium of the sebaceous gland, which, being subjected to the pressure of the unyielding textures in which the tumor is developed, becomes converted by slow degrees into a tissue closely resembling horn or fibro-cartilage" (Birkett, *Guy's Rep.*, 1859).

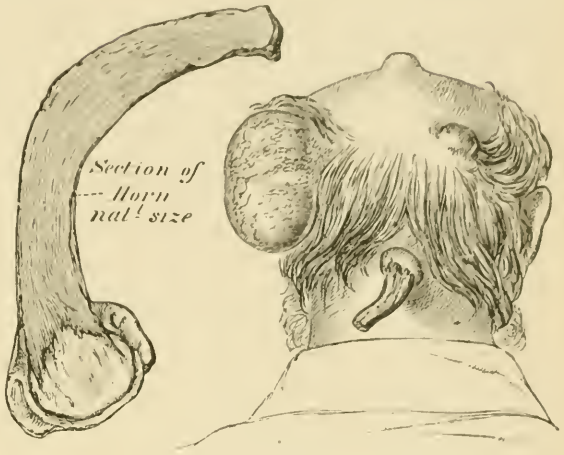
These sebaceous tumors are more frequent in women than in men, and are, beyond doubt, hereditary; Sir J. Paget says "they are certainly more commonly hereditary than are any forms of cancer."

The dermoid cysts of the ovary are only of pathological interest, as are the dentigerous

cysts of these parts. The dentigerous cyst of the jaw will be treated of in the chapter on diseases of the jaws.

Oil cysts are met with, though rarely, and they are probably always dermoid. I removed one from the parotid region of a girl æt. 18 which was congenital. It contained liquid oil (*Path. Soc. Trans.*, vol. 33, 1882).

Fig. 39.



Sebaceous Tumors in Scalp, and Horn.

Treatment.—The only correct treatment of these sebaceous or skin cysts, whether whole, broken, or fungating, consists in their removal. In removing "wens" or *acquired* cysts, however, it is not necessary to be too careful in dissecting them out entire, and the most effective method is to slit open the tumor with a bistoury and then turn it out with the forceps or handle of the knife. In the removal of sebaceous cysts from other parts of the body the capsule of the cyst should be taken away, while in the fungating tumor the whole mass ought to be excised. In the treatment of the *congenital* tumor it is always better to try and dissect out the cyst entirely; but nothing is more unsatisfactory than operating in such cases, for the cyst is always deep, its capsule thin and adherent, and any attempt to dissect it out as a whole is too often foiled by the bursting or puncturing of the capsule and the escape of its contents. When this occurs, the surgeon must take away as much of the capsule as he can and then close the wound, a good result following, as a rule, though at times a recurrence of the growth will ensue.

The fear of erysipelas after these operations is really almost groundless. It may arise, but out of more than one hundred cases consecutively observed I have not seen one example. Pyæmia may follow this, as it may any other minor operation, but not more frequently. When patients are cachectic, such an operation of expediency as that for the removal of a "wen" had better be postponed; for under low conditions of health blood-poisoning is likely to follow. Should, however, its removal be urged, this may be done by the injection into the cyst of some caustic, such as a few drops of deliquescent chloride of zinc, of carbolic acid, or the external application of nitric acid or potassa fusa, to produce a slough through the skin, when the contents of the cyst may be turned or drawn out.

THE MICROSCOPICAL ANATOMY OF TUMORS.

By Dr. Moxon.

Every texture of the body in its earliest embryonic stage of development is altogether composed of cells which have in their primitive condition no noticeable substance between them. As the texture progresses in its development the uniformly cellular composition of its primitive substance undergoes modification. Some of the cells become separated by intercellular substances of various kinds; others change to capillaries, lymphatics, and nerves; yet others retain their cellular form and remain in close contact with each other. The general result is that when the several textures of the fully-developed frame are studied in the course of minute anatomy, each texture is found to shew in its ultimate construction some remains of its cellular origin, more or less evidently recognizable. In some tissues, such as the epithelial coverings and linings and the cellular parts of the lymphatic glands, of the thyroid, etc., the cells remain always distinct from each other, although in close mutual contact. In the several kinds of tissues of the connective class, including cartilage, tendon, bone, etc., a large proportion of intercellular matter separates the cells, this intercellular matter taking the form of hyaline or elastic substance, as in cartilage; of fibres, as in connective tissue and tendon; or of calcified substance, as in bone. The cells remain separate in cartilage, but in the other tissues of this class they send out processes which unite to form a network throughout

the calcified or fibrous intercellular substance which constitutes the greater part of the tissue.

Tumors of Nonstriated Muscle.—In the proper substance of muscle and nerve, tissues endowed with special dynamic powers, the original cells generally blend more completely, composing tubes or fibres. These tissues show very little disposition to form tumors, or even to share in their formation. There is one exception to this indifference in the case of nonstriated muscle: the fibres of this kind of muscle retain to a large extent their embryonic characters and never quite lose their primitive cellular composition; the original cells are comparatively little altered and remain still distinct. And with these embryonic characters the fibres of nonstriated muscle show a capability of extensive new growth; rapid production of this tissue occurs during adult life in the pregnant uterus. And tumors of nonstriated muscle fibre are not uncommon in the uterus and elsewhere. This texture is, indeed, of great interest pathologically, as showing the association of a power of new growth in a highly endowed tissue, with a persistence of embryonic form in its elementary fibres. It is perhaps the most striking example of what is generally true in both normal and pathological histology—namely, that with embryonic form in texture elements goes always power of increase and multiplication.

Blood Vessels in New Growths.—The behavior of the blood vessels in the formation of new growths is an interesting field of study, in which useful observations may yet be made. It will be found that the blood vessels which arise in tumors composed of normal adult texture, such as bone, fibre, etc., are themselves composed of the textures proper to normal adult blood vessels; but, on the other hand, the blood vessels of tumors which are composed of embryonic substance are themselves also composed of more or less embryonic cell-forms.

The constitution of the blood vessels in any growth must be considered when we are endeavoring to throw light upon those conditions which enable a tumor to infect the blood passing through it, so giving rise to secondary tumors in the course of the circulation. There are tumors in which blood vessels attain to undue proportion, and sometimes tufts of blood vessel make up almost the whole of a new growth. Such tufts, projecting on a free surface, bring danger of serious hemorrhage.

Activity of Embryonic Cells.—The discovery within a tumor of any large proportion of embryonic cells may generally be taken as a sign of active growing power. Such cells are known by their indefinite transitional shapes, their large nuclei and many nucleoli. These cells were formerly looked upon as special to the more dangerous kinds of new growth, and were spoken of as "cancer cells." It was thought that one might know a cancer by the presence of such cells.

But you cannot find out the character of a new growth by scrutinizing its cells individually. It is true that some kinds of tumor contain a large proportion of cells that are so far peculiar as to be almost characteristic, such as the giant cells in a form of sarcoma and the lymphoid cells of lymphoma; yet cells of either of these kinds are met with in other forms of tumor. Indeed, it is now generally admitted that the hope of being able to determine the nature of a growth by the study of detached cells must be given up, and the character of a tumor must be estimated by a general consideration of its whole structure, for experience has established the fact that the structure of a tumor indicates its character; so that dangerous tendencies are constant in tumors of certain construction, such as carcinoma, and are as constantly absent in the case of tumors of a wholly different construction, such as adenoma, whilst in yet other tumors there are lesser degrees of danger.

Now, in every tumor the new material is developed, like the natural tissues of the body, from embryonic cells. And in any growing tumor some proportion of such cells is always to be found in the part of the tumor then in the act of development.

But the several kinds of tumor differ exceedingly in the proportion of embryonic and adult material contained in their composition, some appearing to the naked eye to be altogether made up of an adult texture, whilst others are throughout constituted of embryonic substance; and it may be said that the more embryonic substance present in a tumor, the greater will be its rate of increase, and generally the greater the danger attaching to it.

A tumor whose substance differs much from any of the natural tissues is generally a tumor endowed with the embryonic quality of rapid increase, and hence is a dangerous tumor; whilst a tumor whose composition resembles that of any fully-developed tissue, such as bone, fat, ligament, etc., is generally a tumor of slow growth and comparatively little danger. The most important exception to this general rule is in the case of cartilage. Tumors composed of cartilage may grow rapidly and prove dangerous, but it must

be remembered that, although cartilage is a tissue of the adult human frame, yet there is such a thing as embryonic cartilage; and thus, indeed, cartilage may claim to be regarded rather as embryonic than as adult.

When the substance of a tumor develops into adult tissue, the tumor so formed is always composed of one of the proper tissues of the human body, ligament, fat, bone, etc. The tissue thus developed is nearly always the same tissue as that from which the tumor arises—bone from bone, fibre from fibre, fat from fat, papillæ from the papillary layer of the skin, etc. But it must be fully understood that we are here speaking only of primary tumors, for it is most curious, interesting, and suggestive to observe how, when a tumor in any tissue arises as secondary to another tumor in another tissue, the secondary tumor contains the tissue of the primary tumor, and therefore usually the tissue of the seat of origin of the primary tumor. Thus, if a tumor arising from the humerus and containing bone gives rise to a secondary tumor in the lung, the lung tumor will then probably contain bone; but if primary tumors commonly resemble in microscopic structure the parts they arise in, this resemblance is only reached when the tissue of the tumor attains to complete development; for if the elementary cells of the new growth remain permanently in an incomplete stage, and do not go beyond the form of embryonic cells, the substance of the growth will of course have characters differing from those of the adult tissue wherever it arises, and it may differ exceedingly from the adult form of that tissue.

Indeed, if any primary tumor does not resemble the texture it arises in, this is nearly always because its substance is in an embryonic state or stage. But with this embryonic stage is naturally associated a power of increase; and hence it is that when a tumor does not resemble the tissue in which it grows, that tumor will probably prove to be a rapidly increasing, and therefore a dangerous, tumor.

It is not, however, only through great growing power that a tumor becomes dangerous. The chief danger, and the most dreaded danger, lies in the tendency of the tumor to prove infectious either to the adjacent tissues or the corresponding lymphatic glands or to more remote organs and parts of the system.

By infecting the neighboring textures the tumor will grow again from them after the surgeon has done his best to remove it. By infecting the glands secondary tumors arise in the seats of those glands, whilst by infecting the walls of blood vessels, or otherwise setting free its germinal particles in the blood stream, the tumor gives rise to secondary growths in the great vascular viscera, the lungs and liver, or in the cancellous tissue of bones, or generally elsewhere.

The possession of this infective power is what is meant by the term "malignant," and the word "cancer" is popularly applied to any malignant tumor.

The microscopic structure of a tumor may throw some light upon its malignant or infective powers. Thus careful inspection of sections of the edges of the tumor may discover that its cells are already spreading into surrounding parts when no sign of their presence is given to the unaided eye. Or it may be found that minute blood vessels have their walls invaded and transformed by the new formation. A large proportion of juice in the texture of the growth, especially if there be also a large share of easily movable particles, will usually be associated with infective powers. The microscope reveals that these particles are actively-growing nuclei and cells. It thus explains the usual rough test by which a tumor is tried for malignancy when the cut surface of its section is scraped, and a milky juice being obtained is held to characterize a cancer.

But the proper manner of judging a tumor is by a thorough examination of its histological structure and a reference of the tumor to its proper structural kind.

General experience has shown the degree of danger belonging to each sort of tumor, and by a knowledge of the structure of tumor its tendency may be fairly inferred. From the histological point of view tumors may be divided into the following groups.

OSTEOMA, OSTEOID CHONDROMA, ENCHONDROMA.

When bone forms a large part, or apparently the whole, of a tumor, the tumor is called an osteoma; but no tumor is ever formed altogether of bone: there is always present an ossifying matrix, by the ossification of which the bony part of the growth enlarges. The kind of matrix varies much. Thus sarcomata, or even carcinomata, may directly ossify, and so we get *osteo-sarcoma* and *osteo-carcinoma;* but the kinds of matrix which produce growths of practically a bony nature are generally two—viz., periosteum and cartilage. Periosteum—or, to speak more exactly, a tissue resembling closely the

deeper layer of the periosteum—forms large tumors whose transformation into bone takes place in the manner shown in the left side of Fig. 40; the cells take the shape of bone cells, and the matrix calcifies. These tumors are called *osteoid chondroma* or *periosteoma*.

Cartilage often appears to be ossified when it is only petrified by deposit of calcareous

Fig. 40.

Microscopical Anatomy of Osteoma, Osteoid Chondroma, and Enchondroma.

salts in its matrix (see right side of Fig. 40); this change is, as is well known, the first step in ossification of cartilage. In many cartilage tumors the process goes no farther, or it may proceed to complete ossification through the several stages shown in the right size of a figure—viz., vacuolation, formation of medulla-cells in the vacuoles, and direct transformation of these to bone cells, as seen in the lower and right part of the drawing. More rarely the cartilage cells, without calcifying, proliferate and change directly into bone, as seen in the middle of the figure.

The amount of cartilage, periosteum, or bone present varies indefinitely in different cases. When cartilage preponderates, the tumor is called an *enchondroma*; when bone preponderates, an *exostosis*, *osteoma*, etc., according to its shape and connections; when periosteum preponderates, an *osteoid chondroma*, as before said.

Occasionally the amount of bone and cartilage is so equal that it is a matter of difficulty to decide which name shall be used, and then the term *cartilaginous exostosis* or *ossifying enchondroma* is employed. *Osteoid chondromata* are to be suspected of malignancy; such tumors compose a part of what were called *osteoid cancers*, and now called sarcomata.

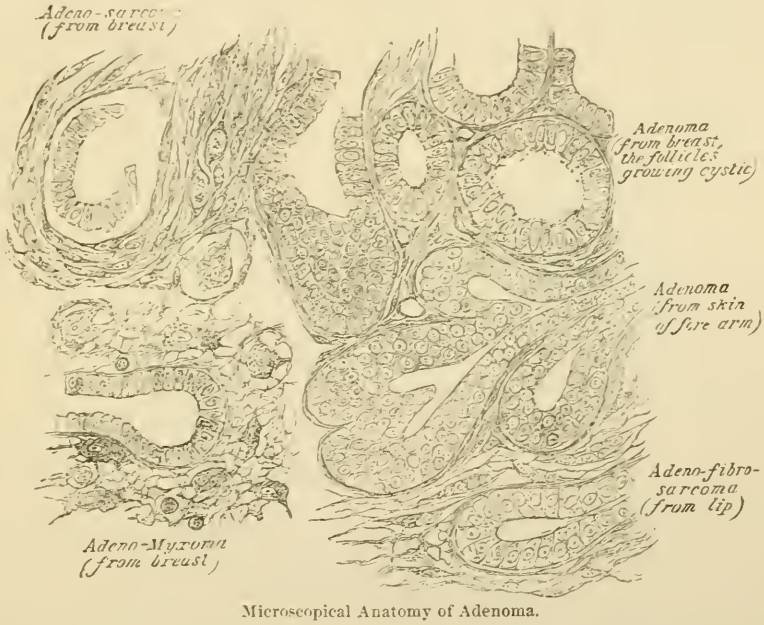
ADENOMA.

The essential character of adenoma lies in the possession of a glandular structure, but the comparative amount of the glandular element varies much. There is also variety in the kind of tissue which is found between the gland follicles. Some tumors show structure almost identical with that of compound racemose glands, having natural-looking follicles separated by delicate connective tissue; more commonly the follicles are dilated more or less, so as to form cysts; one or more of these may prevail, so as to give a cystic character to the whole (cystic adenoma). Besides the cysts arising in this way, others may be formed by a breaking down of the intermediate tissue, especially if it happen to be mucous tissue. But, as a rule, the glandular elements are surrounded and separated by a more plentiful formation, which may be so much developed as to more or less entirely take away the glandular character of the growth; this interstitial tissue may either be fibrous, sarcous, or mucous, or more rarely cartilaginous or areolar, or it may present characters combining these or mediate between them (*adeno-fibroma—sar-*

coma—myxoma). When the proportion of gland is small, there is doubt whether it is not part of the original gland-tissue persisting in the new substance. Thus, the relative augmentation of the cavities of ducts or follicles may make the tumor take the character of cyst, or the relative augmentation of the intermediate tissue may make it take the character of sarcoma, myxoma, or fibroma; but if the glandular substance is maintained in due proportion, the natural resemblance of adenoma is to carcinoma.

And, indeed, if the glandular substance is maintained in due proportion, then a very little change is needed to give to adenoma the characters of carcinoma. When the characters of carcinoma are studied, it will be found that these characters are of the same general description as those of adenoma. In either case there is a meshwork of fibrous or sarcous substance, forming spaces in which cells of a more or less epithelioid type are packed together. The difference is one sometimes requiring close observation, and not always to be determined quite satisfactorily, whilst in other cases it is obvious enough. The structural difference between adenoma and carcinoma lies in this—that in an adenomatous tumor the glandular epithelium is regular and composed of even-sized and relatively small cells whose nuclei are generally single and do not contain many nucleoli; the

FIG. 41.


Adeno-sarcoma (from breast)
Adenoma from breast, the follicles growing cystic
Adenoma (from skin of fore arm)
Adeno-fibro-sarcoma (from lip)
Adeno-Myxoma (from breast)

Microscopical Anatomy of Adenoma.

cells do not vary in form, and line the follicles of the adenoid texture in an even and orderly manner; whilst in carcinoma the nuclei in the cells are larger and brighter and have many nuclei, and the cells vary much in form and size and compose usually compact masses projecting into irregular bulbs in the sarcous stroma, instead of lining follicular cavities.

LYMPHOMA.

The name "lymphoma" is given to such growths as have a microscopic structure like that of lymphatic glands—in particular, which have a finely reticular meshwork, connected with which are some fixed cells at tolerably regular intervals, not unlike the fixed cells of connective tissue, but generally larger. Within the meshes of this network are numerous cells which resemble lymph cells, and hence are also like pus cells and white blood cells. The proportion of network to the contained lymphoid cells is variable: sometimes the quantity of fibre is great, and the structure is then like lymph-gland tissue hardened by chronic inflammation. In other cases the proportion of cells becomes very large, while the network grows very delicate and open-textured. The fixed stellate cells here appear to multiply and produce a progeny of the loose movable cells in the meshwork, as if infected by the latter. The whole mass then appears as fine filaments making bold meshes, which are filled with round granular cells like lymph cells, but generally larger than these, and having large nucleus and many bright nucleoli. Such

cells at first appear to make up the whole substance, but they easily brush or wash out of the meshes, leaving the network very conspicuous. It will be noticed that the degree of structure here described is very rudimentary. Indeed, sections of *ante-mortem* blood clot from within a vein (see figure) closely correspond to the description. So also does tubercle in the more recently formed outer edge of it, where its texture is very like blood clot; hence it is by some classed with lymphoma. Scarlatinous tonsils and typhoid Peyer's patches likewise have lymphoma structure. However, the plan of structure is so meagre that it is not enough to form a bond of union between diseases clinically so remote.

When found in the form of tumors, more properly so called, lymphoma generally takes its rise in the lymphatic glands; those of the neck are especially liable to it, then

FIG. 42.

Microscopical Anatomy of Lymphoma.

those of the abdomen and of the mediastinum. It is also found in the alimentary canal, especially the small intestine and stomach, and in the spleen, liver, kidney, etc. Formations of a similar structure have been met with in various organs in leukæmia, chiefly in the liver, in the form of small grains of a pale substance.

Lymphoma may prove malignant—that is, infectious to parts around—especially when the cellular elements are very numerous (in which case the tumor is called "lympho-sarcoma" by Virchow); it then corresponds to a part of what used to be included under the whole name "medullary cancer," which, as formerly used, would include also soft sarcoma and soft carcinoma. Indeed, these tumors, when the cell elements greatly preponderate, become very much like each other, if not undistinguishable as far as their mere structure is concerned.

SARCOMA.

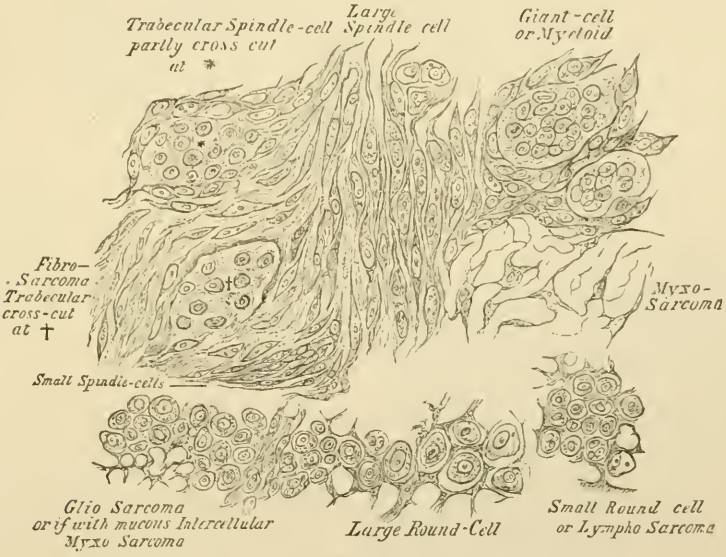
The schematic figure (43) is composed of accurate drawings of portions of the several kinds of sarcoma named, but they are gathered together in a diagrammatic way, the forms being graduated into each other as they are when found side by side in the same tumor. You meet, indeed, with all gradations of intermediate forms; for although, as a general rule, one kind of sarcomatous tissue prevails in a tumor, it is far from unfrequent to have more than one of the kinds present together, the characters of each changing into those of the other.

The distinctive histological character of *sarcoma* is the possession of a stroma between the cells, an atmosphere of intermediate matter which surrounds each and is between them all; the qualities of this intermediate or "intercellular" matter determine the kind of sarcoma, as in the class of connective tissues whose developmental stages the several kinds of sarcoma closely resemble. The class of connective tissues includes the several

kinds of texture whose office in the body is passively mechanical, either in serving as adjuncts to the muscular system or by filling up interstices between organs of the body or by entering into textures to support their component parts, blood vessels, etc. Those connective tissues which penetrate into any of the organs of the body are modified in consistence and in arrangement of their elements according to the requirements of the organ. Thus, in the brain the connective tissue, called "neuroglia," is very delicate and soft and has scarcely any distinctness. Also the connective tissue which enters into the lymphatic glands becomes reduced to very soft fibrillar matter between the lymph cells. In these instances, and in others, the connective tissue thus comes to have peculiarities and to constitute strongly-marked varieties. Yet all connective tissues possess this common feature in their elementary structural composition—that they are made up of cellular bodies between which their proper substance forms an intercellular matter.

The relation of sarcoma to the connective class of tissues appears to be this—that when one of these tissues is produced very rapidly it has no time for its intercellular matter to acquire the proper characters, and so remains indeterminate, while it also is small in quantity, the cells greatly preponderating. Thus, any of the normal connective tissues may produce by rapid development a tumor of sarcous tissues or sarcoma (the name is well chosen: σαρξ, which equals *caro* or our word *flesh*, means commonly any soft animal substance, not blood nor bone). Thus it follows that there are several kinds of sarcoma, according to the tissues from which they are developed. The principal of

FIG. 43.


Trabecular Spindle-cell partly cross cut at *
Large Spindle cell
Giant-cell or Myeloid
Fibro-Sarcoma Trabecular cross-cut at †
Myxo-Sarcoma
Small Spindle-cells
Glio Sarcoma or if with mucous Intercellular Myxo Sarcoma
Large Round-Cell
Small Round cell or Lympho Sarcoma

Sarcoma.

these are seen in the above schematic figure. The round-celled kinds generally arise from lymph gland or neuroglia or mucous tissue; hence they are common in myxo- or glio- or lympho-sarcoma. The spindle-celled kinds arise from connective, fibrous, or bony tissue, and hence are most common in fibro-sarcoma or osteo-sarcoma.

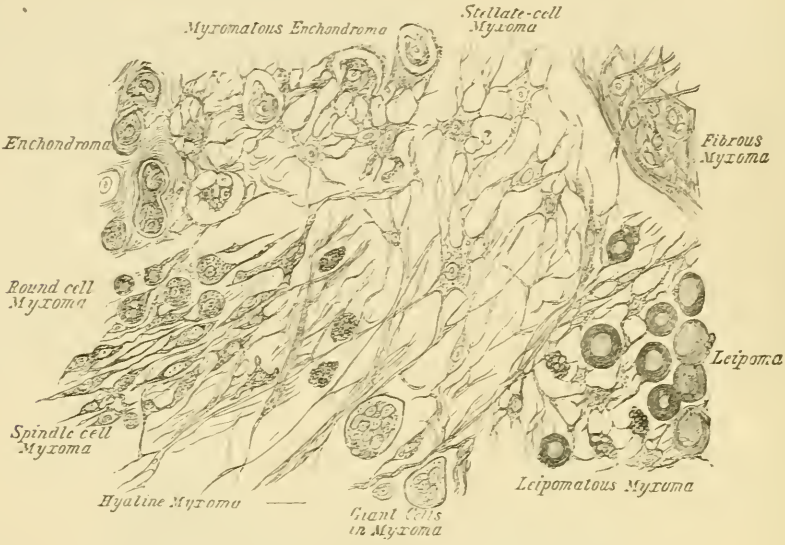
One other form of sarcoma is usually described, the alveolar sarcoma, which is not mentioned here. It is a rare form of tumor, and resembles superficially a cancer or carcinoma. It is formed of a stroma, which maps out large spaces, and these are filled with large round cells. By careful pencilling the characteristic intercellular substance may be distinguished.

MYXOMA.

The name "myxoma" is given to all tumors of connective-tissue type (not epithelial) which contain mucus or mucin in their intercellular matter. It corresponds nearly to gelatinous sarcoma, collonema, and fibro-cellular tumor of old authors; the forms of the cells are very variable, but in the most typical examples, and especially in the older and fully developed parts, the cells are large and usually multipolar or "stellate," with a distinct nucleus and nucleolus; the stellate branching rays of the cells are mutually con-

nected. so as to form a more or less open network, in the interstices of which the mucous semi-fluid lodges. Beams and bands. which generally have a stiff, rigid appearance and an angular rather than a wavy disposition, pass about. dividing up the substance of the tumor into very imperfectly defined sections more or less visible to the naked eye; from

FIG. 44.



Myxoma.

these arise fine fibrils continuous with the cellulo-fibrillar network. Much of the tumor. and especially the younger part, may be found formed of spindle-cells: these are really connected. by threads from their sides, with the intermediate fibrillar network. and it can often be seen that the stellate forms are produced by the drawing out of these threads to greater lengths. through the separation of the texture elements by the increasing quantity of mucus. In yet other examples or parts the prevailing form of the cells is round or with one pole: the round cells resemble ordinary mucous corpuscles and are scattered among the fibrils in the mucoid matter: they also contain many fat-grains and are found in the oldest parts of the tumor. representing the senescence of its cells. There is also a great variability of the intercellular substance—first. in proportion of the fibrous to the cellular part: and second. in the proportion which these solid elements bear to the mucoid interstitial matter: thus. there is a fibrous myxoma and a clear pellucid variety. with much mucous fluid. perhaps even forming cysts (hyaline and cystic myxoma). In some examples there are large polynucleated cells identical with the so-called giant cells of "giant-cell" sarcoma.

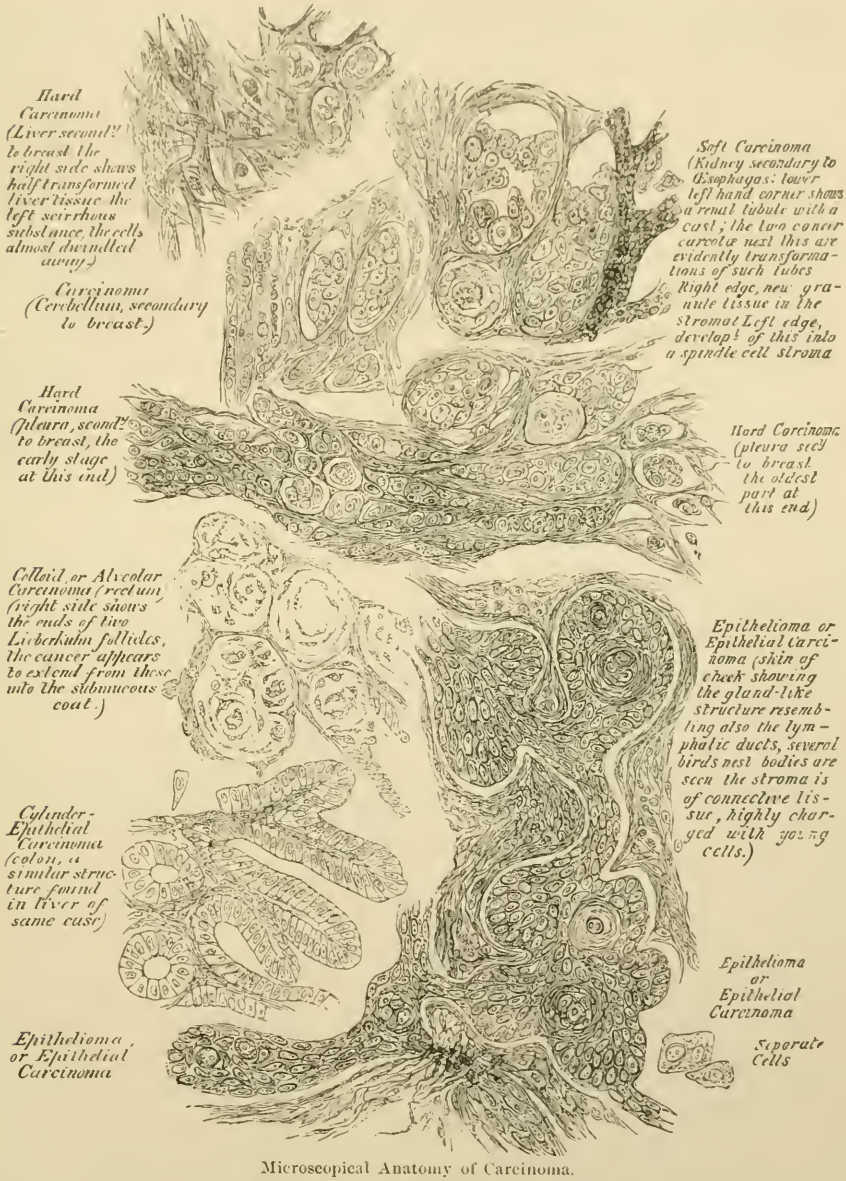
In the theory of types. myxoma is affiliated to certain natural tissues. in particular the jelly of the umbilical cord. the vitreous of the eye at a stage of its development. and the early stages of adipose tissue. or to a stage of bone formation out of cartilage. It will be seen that these typical tissues are only transitory in their nature as compared with such stable tissues as bone. cartilage. tendon. In accordance with this instability of their type. myxomas themselves show many transitions to various kinds of connective tissue: these transitions are chiefly toward cartilage or fat (myxomatous enchondroma. myxomatous lipoma). Tumors are not infrequent. especially in the parotid region. which are intermediate between cartilage and mucous tissue. so that one cannot say to which they most properly belong: also many fatty tumors show clear gelatinous patches of mucous tissue in all transitions to fat, while many myxomata show opaque spots composed of true adipose tissue.

CARCINOMA.

The term "carcinoma" is now distinctively applied to such tumors as have a structure of the following description—viz.. a meshwork of fibrous or sarcous substance composing an alveolar structure. whose interstices are filled with cells. These may have no orderly or methodical-looking arrangement. being packed in the crevices in the meshwork (or alveoli. as they are called) and extending casually from alveolus to alveolus. so as to

make a complementary meshwork. The carcinomatous character is determined by the presence of such alveolar structure with cell collections lodged in it; the decisive point consists in these cells lying close together without any intercellular substance: the cells generally vary in shape and have large nuclei, with large and bright nucleoli. But often the cells have an arrangement very like the epithelial lining of the follicles of the secreting glands—a structure which may be so well pronounced as to bring them almost into

FIG. 45.


Hard Carcinoma (Liver secondy to breast the right side shows half transformed liver tissue the left scirrhous substance, the cells almost dwindled away.)
Soft Carcinoma (Kidney secondary to Esophagus: lower left hand corner shows a renal tubule with a cast; the two cancer cavities next this are evidently transformations of such tubes Right edge, new granule tissue in the stroma Left edge, develop^t of this into a spindle cell stroma
Carcinoma (Cerebellum, secondary to breast.)
Hard Carcinoma (pleura, secondy to breast, the early stage at this end)
Hard Carcinoma (pleura secd to breast the oldest part at this end.)
Colloid, or Alveolar Carcinoma (rectum (right side shows the ends of two Lieberkuhn follicles, the cancer appears to extend from these into the submucous coat.)
Epithelioma or Epithelial Carcinoma (skin of cheek showing the gland-like structure resembling also the lymphatic ducts, several bird's nest bodies are seen the stroma is of connective tissue, highly charged with young cells.)
Cylinder-Epithelial Carcinoma (colon, a similar structure found in liver of same case)
Epithelioma or Epithelial Carcinoma
Epithelioma or Epithelial Carcinoma
Separate Cells

Microscopical Anatomy of Carcinoma.

continuity with adenomas; they differ from these chiefly in their history, as being infectious, so as to extend into the neighboring tissues, to the glands, or to the viscera, the structure showing only those minor peculiarities which I have just described.

Five leading types of carcinoma may at present be conveniently distinguished:

1st. Those in which the fibrous meshwork is in preponderance and the epithelioid contents of the alveoli are scanty, and perhaps also prone to perish early, so that they are found more or less degenerate within the fibrous meshes: Hard Carcinoma, or Scirrhus.

2d. Those in which the fibrous meshwork is in smaller proportion and the epithelioid

contents are plentiful, making large collections of cells, but with no evident approach in the form of these collections to the shapes of gland acini, and no evident resemblance of the component cells either to the columnar epithelium of mucous glands or the squamous epithelium of cuticle: Soft Carcinoma. This kind occurs especially in glands, and the transformation of the glandular tubes or follicles to cancer alveoli can be seen in all stages in the growing margin of the tumor. (See the two upper drawings in Fig. 45, from the liver and kidney.)

3d. A structure essentially such as that last described, but with this difference—that the epithelioid cells have a quantity of mucus between them, which is regarded as arising from a transformation of them. This change to mucus may be carried to such an extreme that scarcely any cellular elements are left, while the alveolar meshes in which the mucus is contained become very strikingly visible from their nakedness and the pellucidity of the mucus: Colloid, or Alveolar Cancer. A common seat of this is the wall of the alimentary canal, where it may be traced arising from Lieberkühn's follicles.

4th. A structure in which the epithelial cells resemble squamous epithelium and form masses which are very like the follicles of cutaneous glands, or occasionally like rudimentary hairs; the tubular and bulbous forms may, however, be seen ramifying like the lymphatic vessels of the skin, as if their form were moulded to the lymphatic plexus: Epithelioma. In these cancers peculiar bodies are found, composed of flattened cells disposed concentrically so as to form a scaly-walled globe (*a*, Fig. 45) whose appearance is like the section of an onion or like a bird's nest; these are so large as often to be visible to the naked eye; when they are numerous and well characterized, they are diagnostic. Some authors (Billroth) distinguished a variety of this cancer in which the stroma preponderates over the epithelial part, calling it scirrhus of the skin: Squamous Epithelial Carcinoma.

5th. A structure in which the epithelial cells resemble ordinary columnar epithelium, and the structure itself is quite like normal mucous membrane, in which it always primarily arises (alimentary canal, especially colon, uterus); the secondary formations which occasionally occur in these cases, in the liver especially, have the same structure, and thus a tissue like the glandular mucous membrane of the colon may be found in the liver: Cylindrical Epithelial Carcinoma.

The fourth and fifth varieties are distinguished from the three first as epithelial cancers or epitheliomata. Some authors have used the term "cancroid" for the fourth variety, as though it were not completely cancerous. These are less likely to infect the viscera than the first two varieties, which are the most infectious of all tumors, though they are very far from being the only kinds of infectious tumors.

Virchow, *Die Krankhaften Geschwülste*, 1862–5.—Paget, *Surgical Pathology*, 1870.—Abernethy, *On Tumors.—Pathological Society Trans.*—Wilks and Moxon, *Pathology.*—Billroth, *Élémens de Pathologie Chirurgicale*, 1868.—Holmes, *System of Surgery*, 1882.—*Debate on Cancer of Pathological Society*, 1874.

SURGERY OF THE CUTANEOUS SYSTEM.

CHAPTER IV.

CONTUSIONS.

A "**contusion**" is an injury, caused either by a fall, a blow from a blunt instrument, or severe pressure, in which there is no solution of continuity of the skin. The degree of injury depends upon the amount of force applied and the resisting power of the tissues injured. Healthy tissues suffer little where the soft or unhealthy suffer much. The subjects of hæmophilia fare worse than all others. When the force has been sufficient to produce rupture of the small vessels in the skin and subcutaneous tissue, an "*ecchymosis*" or "*bruise*" is said to exist; when it so injures the deeper tissues as to cause effusions of blood from rupture of some of the larger vessels, "*extravasation of blood*" is said to be present; when the blood effused forms a local swelling, it is known as a "*hæmatoma*."

After a **slight contusion** there may be no bruising, but only local pain and swelling, the swelling becoming red and then disappearing. The wheal that rises after a lash with a whip is the best illustration of this condition.

An "**ecchymosis**" is an effusion of blood *into* the skin and subcutaneous tissue, and it shows itself, according to the force employed and depth of tissue injured, within a few minutes or hours of the injury, as a livid red, deep-blue, or black patch, which in the course of twelve or eighteen hours becomes larger and lighter at its margins. About the third day it assumes a violet tint; on the fifth, an olive brown; on the sixth, a green; on the seventh or eighth it has a yellow aspect, and this, fading into a lemon tint, then disappears altogether. An ordinary bruise generally runs through all these stages in about two weeks, the rapidity of the process depending much upon the amount of blood effused and the reparative power of the patient. When no blood has been effused into the skin, but "extravasation" has taken place in the deeper parts beneath a dense fascia, the discoloration of the integuments may not appear for three, four, or even fourteen, days, while in some cases, where the blood has made its way between the tissues and reached the skin away from the seat of injury, the "ecchymosis" will be at some distance from the spot at which the injury was received and may not show till late. When much effused blood exists, the swelling will be great.

The *absence* of ecchymosis is no proof that a contusion has not been experienced, since a fatal rupture of deep parts or of some viscus may be present without any external signs of injury.

On making a section of a bruised part the skin will be found throughout its thickness infiltrated with blood and firmer and thicker than natural; whereas, when the effusion has been the result of violence applied to the body after death, the blood will be beneath or upon, but not in, the cutis, and it will be in small quantities and venous.

Neither *purpuric patches* nor those of "*erythema nodosum*" ought to be mistaken for bruises. The general diffusion of the spots over the body in the one case, and the history and the general aspect of the other affection, should prevent the error. It should be remembered, however, that in purpuric patients and in "bleeders" a slight blow or pinch may be followed by a severe bruise.

A **severe contusion** may cause a rupture of a large artery or vein, under which circumstances a fatal extravasation may ensue; or it may so crush or pulp the tissues as to destroy their vitality: this a spent cannon-ball may accomplish; or it may so rupture a viscus as to cause death. More frequently, however, a severe contusion causes a separation of the skin from the deep fascia and deeper parts, with more or less extravasa-

tion of blood into the split tissues. The effects of a contusion also vary according to locality; thus, in an adult, a blow over the scalp may be followed by a local effusion of blood, and in a child this effusion may go on so as to form a swelling involving more or less of the whole vertex. In the buttocks and loins blood may be so effused as to give rise to a large fluctuating tumor. In the loose cellular tissue of the scrotum or female genitals an effusion of blood may give rise to enormous enlargement, and in the eye every one is familiar with the change.

Where the extravasation of blood has been extensive, the removal of the clot is a work of time. In some cases the blood remains fluid for a long period, and at length becomes absorbed; in others it breaks down and gives rise to suppuration. In some, again, it persists for weeks as a large blood tumor, and then suddenly softens down and is absorbed. In exceptional instances it becomes apparently encysted; and "there is sufficient reason to believe," says Paget, "that blood extravasated in a contusion may be organized, acquiring the character of connective tissue, becoming vascular, and taking part in the repair of the injured tissues," as is seen in the repair of fractures and in ligatured or twisted vessels.

TREATMENT.—A slight bruise, if *left alone* and not manipulated, will get well; for blood is often rapidly absorbed, as is seen in the eye. *To check extravasation*, cold is the best application, in the form of pounded ice in a bag, or a mixture of salt and saltpetre, or the iced poultice,[1] or, what is far better, Leiter's metallic coil (Fig. 9, p. 49), and in an extremity elevation of the limb with rest. To check any inflammatory action during the progress of the case cold is equally effective. To hasten the absorption of the effused blood tonics are often of service, and the application of gentle pressure by means of bandages or strappings is valuable.

A lotion of the tincture of arnica one ounce to a pint of water, or one of the stimulating liniments, such as the soap or opium, seems to have some influence in hastening the absorption of blood.

In cases in which there is extensive effusion of blood, and where the circulation in the part is interfered with, lint soaked in oil and covered with cotton-wool is the best dressing to maintain warmth in the part; moist applications are not good.

When the blood remains fluid and is not absorbed, the surgeon need be in no hurry to interfere, for occasionally interference brings trouble, although, when time presses, the use of the "aspirator" to draw off the blood—or, rather, bloody serum—often expedites recovery. When aspiration has proved ineffectual and a blood-clot remains, this should be evacuated by a free incision, and the exposed cavity irrigated with iodine, boracic acid, or carbolic lotion and then drained, well-applied pressure and immobility of the part being employed. When the blood has broken up and suppuration appeared, a free incision is essential, the case subsequently being treated as an abscess.

ARROW WOUNDS.

These, which are punctured and incised wounds, have been made the subject of a special essay by Dr. Bill in the *American Journ. of Med. Science*, vol. xliv., 1862. He tells us that it is exceptional to meet with single wounds, the American Indians discharging their arrows so rapidly—an expert delivering six in a minute—that if one takes effect it is immediately followed by others. The Washington Army Medical Museum contains specimens of penetrating arrow wounds of the skull. Where both tables are punctured there is little or no fissuring externally or internally, as the vitreous table is penetrated as cleanly as the outer. "This is in such marked contrast to the results of bayonet or sword thrusts, or of the impact of gunshot projectiles, as to merit notice."

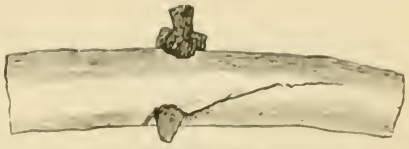
Arrow wounds of the chest are not always fatal; those of the abdomen are generally so. Dr. Bill tells us that the Indians, on this account, always aim at the umbilicus, and that the Mexicans when fighting the Indians, on this account, always protect the abdomen.

The velocity of the arrow when first projected is so great that it has been estimated

[1] *Ice poultices*, as suggested by Maisonneuve, are excellent for the local application of cold, and are made as follows: Take of linseed meal a sufficient quantity to form a layer from three-quarters to an inch thick; spread a cloth of proper size; upon this, at intervals of an inch or more, place lumps of ice the size of a big marble; then sprinkle them over lightly with the meal, cover with another cloth, folding in the edges to prevent the escape of the mass, and apply the thick side to the surface of wound. The exclusion of air retards the melting of the ice, and the thick layer intervening between it and the surface prevents painful or injurious contact. In injuries to the abdomen this remedy is very applicable. Dr. W. H. Doughty of the U. S. A. speaks highly of it. Circular No. 3.

to equal nearly that of a musket-ball, but arrow-firing is ineffective over a hundred yards. At a short distance an arrow will perforate the larger bones without comminuting them, or will cause a slight fissure only, resembling in these respects the effect of a pistol-ball fired through a pane of glass a few yards off. This is well seen in the drawing (Fig. 46).

Fig. 46.



Piece of Buffalo Rib Pierced by Arrow. (Surgeon-General's Office, U. S. Circ 3.)

The wound of entrance in the soft parts is a contused depressed slit; that of exit, a mere slit. When an arrow strikes the skin obliquely, the wound will be that of a long incised wound.

The treatment of these wounds is thus summarized by Dr. Bill (*International Encyclopædia of Surgery*, vol. ii.):

1. An arrow-head must be removed as soon as found.
2. In the search for the arrow extensive incisions are justifiable.
3. An arrow may be pushed out as well as plucked out.
4. The finger should be used for exploration in preference to a probe.
5. Great care must be taken to avoid detachment of the shaft.
6. Healing by first intention should be encouraged.

BURNS AND SCALDS.

A **burn** is caused by the application of concentrated *dry* heat to the body; a **scald**, by the application of hot or boiling liquid. As a rule, scalds are less severe accidents than burns, because water, being the ordinary fluid through which the scald is produced, is never hotter than 212° Fahrenheit; yet when any other chemical compound is the scalding medium, the effects are, at least, often as bad as the worst burns. The worst local burn I ever saw was when a man put his booted foot and ankle into a pot of molten lead. The limb came out covered with a boot of metal, and was destroyed even to the bones. Mr. Aston Key amputated the limb at once below the knee without removing the metal.

A moderate degree of dry heat applied in the pursuit of a calling indurates the skin and blunts its sensibility, and an iron-worker or a blacksmith can manipulate pieces of hot iron that would "burn" ordinary people. Thus, some skins or parts of the body are more sensitive than others, and under the same influence may be differently affected.

The effect of heat when applied to the body varies according to its *intensity* and the *duration* of its application; it may cause a simple redness of the surface or the death of the part.

Thus, its *first* effect is mere *redness* and tenderness of the surface, and after a few hours these symptoms may subside, the cuticle possibly desquamating.

In the *second degree* of heat inflammation is the result, this action manifesting its presence by the formation of a *blister*, from the effusion of serum beneath the cuticle.

In the *third degree* the superficial layer of the true skin is destroyed, the *surface appearing* of a *gray-yellowish or brown color*, not painful unless roughly handled. The vesicles that exist contain a blood-stained or brown fluid. The papillæ of the skin, with its nerves, are first destroyed; but when, in the course of a day or so, the dead surface has been "shed" and the nerves exposed, the pain is very severe and the exposed surface has a reticulated surface.

In the *fourth degree* the whole thickness of skin is destroyed, with more or less of the subcutaneous cellular tissue, the parts being converted into a hard, tough, dry, and insensible eschar mottled with blood; vesication does not exist in this degree, all the superficial tissues having been destroyed. The skin surrounding the eschar may be blistered, but where it comes in contact with the injured part it will be drawn into folds from the contraction, owing to the drying of the burnt integument; this puckering fairly indicates the important fact that the whole skin has been destroyed. The eschar does not begin to separate for four or five days, an inflammatory zone of redness with pain of some severity indicating the commencement of a process that will not be completed for two or three weeks. When the slough has come away, a long and tedious process of suppuration and granulation must be gone through prior to the repair of the exposed parts.

In the *fifth degree* the skin with the deeper parts is involved, a black, brittle, charred mass taking the place of healthy tissues.

In the *sixth degree* the whole thickness of a limb is carbonized.

These divisions, originally made by the great French surgeon Dupuytren, so well

accord with all observation that they have been invariably adopted by modern surgeons; and, although in burns and scalds one degree passes imperceptibly into another and in bad cases coexist, in the main they can be made out.

Prognosis.—Next to the *intensity* of the heat and *duration* of its application, the *extent of surface* involved is the most important point; indeed, as regards life, it is of far greater importance than the other two, because a superficial burn spread over a large surface, although not locally so injurious as a more severe one, is more fatal. In the majority of cases of deaths from burns and scalds, more particularly in children, the risk to life is fairly to be measured by the extent of surface involved; when more than half the body is injured, a fatal result generally ensues. A severe burn of a limited character may be, however, only a local affection.

Thus, the danger to life turns upon many points. In both young and old all burns or scalds of any extent are serious. At any age extensive burns, however superficial, are to be feared, and they become serious from their immediate depressing effect upon the system; patients sometimes die from shock, and the very bad cases are marked by the sensation of *coldness* and persistent *shivering*. When the period of shock—which varies from twelve to forty-eight hours—has passed, and that of reaction has set in, other dangers appear. Should the injury be over the thoracic cavity, chest complications may be looked for; and if over the abdomen, intestinal and peritoneal troubles. Burns and scalds of the head are not so likely to be followed by intracranial as those of the chest are by thoracic mischief. All intestinal complications should be carefully observed, as there seems to be a liability to irritation of the intestinal mucous tract, which may terminate at times in ulceration. Dupuytren first observed this in a general way, but Long (*Lond. Med. Gaz.*, 1840) and Curling (*Med.-Chir. Trans.*, vol. xxv., 1842) showed that ulceration of the duodenum, as proved by inspection after death, and indicated during life by vomiting and purging of blood, is by no means an unfrequent result.

Out of 125 fatal cases collected by Holmes and Erichsen, 16 presented ulceration in the duodenum, of which 5 died during the first week and 5 in the second, the situation of the burn in all but two being on the chest or abdomen. "The ulcer always has an indolent aspect and is situated below the pylorus; often there are two or three close together; the edges of the ulcers are neither raised nor everted; there is little or no evidence of inflammatory effusion in their neighborhood; when they are recently formed, they look simply as if a portion of the mucous membrane had been cut out; but when the ulcer has penetrated more deeply, so as to threaten perforation of the gut, lymph may often be found effused on its peritoneal surface. Sometimes the glands of the duodenum may be found enlarged" (Holmes).

The symptoms of duodenal ulceration are most obscure, as neither pain nor tenderness exists; diarrhœa is neither constant nor excessive; vomiting is perhaps a more common symptom; and the presence of blood in the motions is highly suspicious. When the ulcer has perforated the intestine, intense pain, vomiting of blood, melæna, collapse, and abdominal distension mark the fact.

It should be noted that cicatrized duodenal ulcers have been found in patients who have died of other complications.

Casting Off of Sloughs.—In the *second* or *inflammatory stage* the injured parts are being thrown off, and most writers allow for this process about fourteen days, though in some cases it is less and in others more. When, however, the slough has separated and the parts begin to suppurate, the *third stage*, or *that of suppuration*, has commenced. In this stage, although there may be less probability of visceral complications appearing, there is the equally great danger of exhaustion, hectic, or pyæmia. Should these risks have been surmounted, there is yet the long and tedious process of the healing of the granulating surface, and at a still later period evils arise connected with the gradual contraction of the cicatricial tissue. This contraction only takes place when the *whole* skin has been destroyed. When the surface of the skin merely has been involved, and not its depth, the sore, on the removal of the slough, has a peculiar net-like appearance, with a whitish or yellowish ground, through the meshes of which granulations project.

Cause of Death.—When a person dies from a burn within forty-eight hours, it arises from shock or collapse, pain doubtless having its full influence; when a similar result takes place during either the stage of reaction or of inflammation, it is from visceral complication: and when during the third or suppurative stage, from exhaustion, visceral changes, or pyæmia.

When a person is said to have been "burnt to death," he dies from suffocation, the fumes of the fire destroying by asphyxia, and the fire subsequently burning the body.

Half the cases of burn admitted into a hospital die, and half of those that die do so within the first three days.

The total deaths in England and Wales in a year from burns and scalds are about 2900, the females not being much in excess of the males.

Out of 408 cases consecutively admitted into Guy's, 275 were females, 143 males, the majority being children under five years old. Dr. Steele has also shown, in his *Septennial Report of Guy's for 1868*, that out of 195 cases of burns from fire 60 per cent. died; of 169 scalds, 16.5 per cent. died; of 18 burns from gas explosions, 11 per cent. proved fatal; and of 28 cases of burns from gunpowder, 14 per cent. succumbed, the difference between these classes of cases being very great, burns being four times as fatal as scalds, and these half as fatal again as gas explosions, etc.

Pathology.—Holmes has gone into this question more thoroughly than any other author (*System*, ed. 3d, vol. i. p. 391), and has given us an analysis of 68 fatal cases examined after death. Nine died from shock in the first two days, all being children; 17 from exhaustion, 5 within the week and 12 at later periods; 3, all burns of the scalp, from erysipelas; 3 from pyæmia; and 2 from tetanus. In 11 cases of children cerebral complications caused death, and in most of these the symptoms appeared soon after the accident. In 6 cases inflammation of the larynx proved fatal, evidently from the direct inhalation of the flames; in 12 cases, in which the burn was thoracic, chest complications killed; in 4, abdominal complications proved fatal, and one of these had peritonitis, the result of a deep burn, two had hemorrhage from ulceration of the duodenum, and one had vomiting from the same cause.

Holmes and Erichsen also dwell upon the fact that cerebral and general visceral congestions are always present in fatal cases; indeed, in all the congestion is a passive condition due to the "sudden revulsion of blood from the surface," caused by the skin injury.

Treatment.—In all burns great care should be observed, in removing the clothes, to save the cuticle. Blisters should be carefully punctured and their contents evacuated, the raised cuticle being gently pressed down to the true skin and covered by dressings. When the patient is cold or shivering exists, he should be covered with a warm blanket and placed near the fire, some wine or brandy and hot water being administered. Professor Hebra speaks well of the warm bath under these circumstances. When the injury is extensive, one part should be uncovered and dressed before the other, as a free exposure of the surface tends to increase the shock and adds to the pain.

Exclusion of Air.—As pain is the constant accompaniment of all burns and scalds, and the exclusion of the air from the injured surface the best means of neutralizing it, the surgeon's object has ever been to find some method of treatment by which this result can be secured; and at Guy's Hospital the application of carron oil, consisting of equal parts of lime water and linseed oil, applied on lint and covered with cotton-wool, has long been the favorite remedy, the whole being carefully kept in place by a bandage. At University College the burnt surface, of whatever degree, is well covered with the finest wheaten flour by means of an ordinary dredger. At the London Hospital the application of zinc ointment on lint is employed. Dr. S. Gross of America used white lead paint, and more recently powdered clay has been employed. Some surgeons advocate the use of a lotion of common soda. I have recently been treating burns of all degrees with vaseline and finely-powdered boracic acid spread on lint with marked success. The dressings must not be changed for some days—not, indeed, until they have been loosened by the discharges or become offensive, inasmuch as the process of dressing any large burn is necessarily painful, and consequently injurious. To obviate the necessity of frequent changes of dressing, carbolic acid has been used dissolved in the oil in the proportion of one part to ten or more.

Small burns or scalds may be treated by water dressing, lead lotion, collodion, Friar's balsam, goldbeater's skin, flour, chalk and water, etc. Two parts of collodion to one of castor oil is also an excellent application. In superficial burns this treatment is probably all that is required, the cuticle being re-formed in three or four days, and beyond some increase of redness in the parts the cure is nearly complete. Opium should be given early to relieve pain, and where it is severe the hypodermic injection of morphia should be employed.

When the *first* dressing has been removed and the surgeon is able to make out the extent of tissue injured as well as the depth of the sloughs that are expected to separate, some stimulating dressing may be called for, to hasten the sloughing process. Carbolic oil, made of one ounce of carbolic acid to a pint of olive or linseed oil, is very effective,

or an ointment made of carbolic acid ℥iv, lard ℥iv, and castor oil ℥j; but these drugs will not avail when a very large surface is involved, and under such circumstances they had better be applied to the sloughing parts, and the vaseline and boracic acid, carron oil, or zinc, resin, or creosote ointment, ♏x of the last to an ounce of lard, to the other parts. A lotion composed of one drachm of the compound tincture of iodine to a pint of water or powdered iodoform is also beneficial. Sloughs, as they loosen, should be cut away, but never dragged. Deep sloughs are well treated by poultices, the turpentine ointment hastening their separation. When the surface is granulating it must be treated as any other open sore; and when the entire thickness of skin has been lost, as in burns of the fourth degree, the surgeon's closest attention is needed to counteract the contraction of the wound that will take place, thereby preventing the advent of those frightful deformities with which all are too familiar.

This can be done by extension, applied in some instances through mechanical appliances, in others by means of bandaging and strapping. When the latter is used, the pressure should be exerted over the granulating surface as well as over the cicatricial border. The strapping must be good and made of linen, thin calico and leather yielding too much; and in the majority of cases nearly all requirements can be met by these means. The process of extension must be kept up during the whole period of granulation and cicatrization. Thus, in burns of the anterior surface of the neck, the chin must be extended to the utmost from the sternum; in those of the thorax, the arm must be kept from the side; and where the groin and parts around are involved, the thigh must be kept extended.

Skin-Grafting.—In addition to these means, we possess M. Reverdin's method of skin-grafting—a practice consisting of the transplantation of small portions of true skin, these centres of cutification not only rapidly growing in healthy granulations, but having the power of imparting to the margins of the granulating tissue a skin-forming power which is as remarkable as it is beautiful to witness.

By these means large granulating surfaces may not only be rapidly healed, but healed without such a surface of cicatricial tissue as necessarily exists after ordinary burns or scalds, and therefore without that tendency to subsequent contraction that appertains to cicatrices.

When Amputation Necessary.—When a hand or finger, foot or toe, is charred, amputation must be performed; and where the soft parts are so injured as to slough, the same practice may be called for. The time, and also the necessity, for operation in any patient's case must be left to the judgment of the surgeon.

The constitutional treatment of burns in the first stage is to *prevent collapse* by the judicious use of stimulants and external warmth; *allay pain* by local treatment and soothing drugs, such as chloral or morphia; *maintain the powers of the patient* by simple nutritious food, such as milk, beef-tea, eggs, etc.; and *after* the stage of reaction, when that of suppuration has set in, to prescribe good food of all kinds and tonic medicine.

Complications are to be treated on ordinary principles, understanding that the injury is depressing and requires no additional lowering influence in the way of treatment.

Thoracic complications may be dealt with by moderate doses of tartar emetic and salines, as well as nutritious and possibly stimulating diet.

Abdominal complications, with opium, alkaline remedies such as lime water in bark, and simple diet.

For children an opiate is best given in the form of the opium ointment; while for adults, where the drug upsets digestion, the same plan is equally effective.

Scalds of the glottis will be considered in Chapter XVIII.

Burns and accidents from lightning rarely occur in this country [England], and average about twelve a year. In 1861 there were twenty-six, in 1862 twelve, in 1863 three, and in 1864 six. Holmes, who has written a careful compilation on the subject, tells us that a person struck by lightning is usually more or less completely deprived of consciousness at the time. In many cases this is not so, as in a remarkable example which occurred in the practice of G. Wilks (*Clinical Society's Trans.*, vol. xiii., 1880). This is sometimes a consequence of the shock given to the brain, and is accompanied by more or less paralysis of motion and of common or special sensation. Occasionally, and perhaps more usually, it is merely the effect of fright, and is then only transient. This insensibility sometimes lasts for a considerable time. The paralysis by which it is usually accompanied may last for an indefinite period: in one case it lasted four months; in another, three. It is more common in the lower than in the upper limbs. Other affections

caused by lightning are burns, eruptions of erythema or urticaria, loss of hair over parts or the whole of the body, wounds, hemorrhage from the mouth, nose, or ears, loss of sight, smell, speech, hearing, and taste, or, in rare cases, exaltation of these special senses, cataract, imbecility, or abortion. It sometimes leaves arborescent marks on the body, even on parts covered by clothes, which have often been described as a kind of photograph of neighboring trees or other subjects. Persons not killed on the spot usually recover, though some die from exhaustion; recovery can be hastened by tonic treatment, and galvanism is beneficial in paralysis. Burns caused by lightning are deep and obstinate; sometimes, however, they are mere vesications and should be treated as other burns.

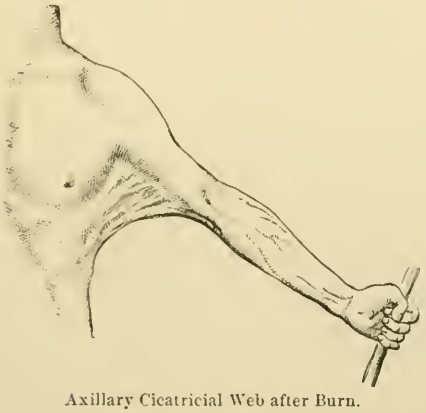
In Wilks's case the man was thrown down and stripped naked of a well-made suit secured with straps and buckles, and stout new hob-nailed boots. The clothes were stripped into shreds and boots burst asunder. The man was burnt superficially where the flannel touched the skin, but deeply where the cotton trousers were in contact. He had also a compound fracture of one leg. Wherever there was a piece of metal (waist-belt, watch, boots) there was an explosion, or at least a greater development of heat. The man recovered completely.

In sudden deaths from lightning the shock to the brain is the cause; the heart is found flaccid and empty, the blood sometimes coagulated; and Taylor tells us, from Sir C. Scudamore's experiments, that in animals killed by electricity the same conditions existed.

The Diseases and Treatment of Cicatrices.

Cicatrices or scars, however produced, grow with the growth of the individual, and at the same time have a tendency to disappear; so that indurated scars may indeed in time become non-indurated. In small scars this is often observed, and even in larger it is so occasionally, the large cicatrices of burns becoming soft and pliable. As often as not, however, the opposite occurs, and the disposition to contract is very formidable, producing deformities of a frightful kind, those of the neck being perhaps the most hideous. The arm may be fastened to the side (Fig. 47), and I have seen in one case the head of

Fig. 47.



Axillary Cicatricial Web after Burn.

Fig. 48.

Mode of Supplying Extension after its Division.

the humerus displaced forward beneath the clavicle, and in a second beneath the coracoid process and the development of the upper extremity arrested by the contraction. There is no limit, indeed, to the effects of such a powerful and constant force as that of cicatricial contraction.

Operative Measures.—The surgeon is called upon not unfrequently to remedy these defects, and where his efforts are successful the surgery is satisfactory, but too often the result is far from what is required.

The operation consists in the free division of the cicatrix and its subjacent tissues, the subsequent extension of the divided parts during the healing process, and the transplantation of different centres of "cutification" during the granulating stage, after the method of Reverdin.

In dividing the cicatrix the incision may be directly across the scar, running into healthy tissue on either side, or in the form of a natural or inverted V, according to the line of induration, the V-flap being dissected from the tissues beneath; or a number of

small incisions may be made, subcutaneous or otherwise. But in all these divisions the surgeon must remember that the seat of the contracting cicatricial material is in the subcutaneous tissue as well as in the skin, and that unless it also is divided no permanent good can be expected. It is on this point—and, indeed, upon it alone—that a prognosis can be based. The most favorable cases for operation are those in which a web of tissue connects an extremity with the body, or the chin with the chest; for such a web contains within itself most of the cicatricial material upon which the deformity depends, and on its division the whole will be freed. Great care is needed, however, in the division of these webs; for they often contain important parts, such as nerves and vessels that have been displaced by the contracting process. Thus, in treating a case in which the right arm was fixed by a web from the axilla and elbow to the chest, the web seemed to be so cutaneous that I was half tempted to perforate with my knife and slit it up. Had I done so in the position I had noted, I should have passed my bistoury across the brachial plexus, artery, and biceps muscle—these parts having been completely drawn across to the thorax by the affection—and then been forced to amputate the extremity. I did, however, what I should always advise others to do—divided the parts carefully and deliberately, and thus steered clear of any harm. I brought also a piece of healthy skin from the posterior part of the wound and fixed it to the anterior about the lower border of the axilla, thus dividing the large exposed surface by a bar of healthy integument, and kept the arm at a right line to the shoulder with a splint extending from the elbow to the hip. When the wound had assumed a healthy aspect, I inserted ten pieces of skin the size of hemp-seed, and after this cicatrization went on with wonderful rapidity, the child recovering with a useful arm and movable cicatrix. In this case I have fairly indicated the points requiring attention to secure a successful operation: free but deliberate division of the cicatrix and subcutaneous tissue, extension from the first during the healing process by some fixed mechanical appliance, and skin-transplantation when the surface of the sore has assumed a healthy granulating surface, the surgeon, where he can, partially detaching a piece of integument from one side and connecting it with the opposite, in order to divide the wound and thus increase its skin margin for granulation. Where a bend in a joint exists this practice is still more valuable. After the operation the wound should be dressed with vaseline on lint and covered with cotton-wool, as in a burn. Fig. 48 illustrates a simple method of applying extension of the arm after the division of an axillary cicatrix of great size, and Fig. 49 illustrates the effects of a burn upon the neck.

Fig. 49.

Effects of Burn on Neck: Contraction of Cicatrix.

In *deformities affecting the jaw* in which immobility of the bone has been produced, Esmarch and Rizzoli have proposed the division of the bone and the excision of a small wedge of bone at the fixed side with a view of making a false joint. The operation is a sound one, and has been accomplished successfully by Mr. C. Heath and others. In suitable cases it should be repeated.

Ulcerating cicatrices are not uncommon, for "new cutis and new-formed granulations are neither so strong, nor have they the living principle so active in them, as the old cutis" (John Hunter, 1787), and an old scar may break up and become the seat of an indolent sore when its possessor has been weakened by any fever or exhausting process, in the same way as old subcutaneous cicatricial tissue may give rise to a residual abscess. I have seen this repeatedly occur in adults in cicatrices formed in infancy. In one case the cause of the scar was a burn, in another an injury, in a third an operation; but in all the scars were alike, and they underwent the same degenerating process. These sores require to be treated by rest and local stimulants, the patient receiving tonics and good food to improve the weakened powers. In one case I transplanted with complete success. These "cicatricial sores" are, however, always obstinate, those over the ends of bones being unusually stubborn.

Warty and cheloid scars are classed together, because it is difficult to distinguish the indurated, lumpy, warty scar from the true cheloid. The former, however, appears directly *after* the wound has healed, and is clearly connected with the healing process; while the latter attacks any scar at any period of its existence.

The thickened warty scar appears as an induration of the whole cicatrix and is often associated with heat and irritation. It is best treated by local stimulants, such as iodine or blistering fluid, the object being to break up by some local inflammatory process the lowly-organized fibrous production.

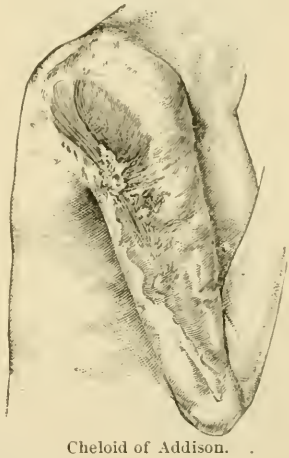
Cheloid tumors grow as indurated smooth tubercles, at first having a red or pinkish color, but as they increase becoming pale. They are at times painful—or, at least, irritable—and rarely attain a large size. They had better be left alone, for they are apt to return in the cicatrix formed after their removal. Cheloid tumors generally grow from cicatrices. These cheloid tumors are known as those of Alibert, to distinguish them from those named after Dr. Thomas Addison, who in 1854 (*Med. Chir. Trans.*) described another form of cheloid, which he calls the "true cheloid," the induration beginning in the skin and subcutaneous areolar tissue, and often going on to produce such a contraction of the part affected as to resemble the indurated cicatrix of a burn. Figs. 50 and 51 represent the two affections.

The cheloid tumor which follows the perforation of the ear for an ear-ring is a curious

Fig. 50.

Cheloid of Alibert.

Fig. 51.



Cheloid of Addison.

(From models in Guy's Museum.)

form, and seems less liable to return than others of a like nature. From the deformity it causes, it should be excised with a portion of the healthy lobule.

Cancer may attack a scar; and when it does so, the scars are generally old. Thus, I have treated a man who had a cancerous lip, the disease having developed in a scar he had had for fifty years. It began as a thickening of the scar, and then showed itself as a tubercle, which grew, broke down, and ulcerated, the ulceration rapidly spreading.

In December, 1871, I was called upon to amputate above the knee in a man æt. 58 a leg stump that was the seat of a frightful cancerous disease which had existed for two years, and had appeared in the cicatrix of an old amputation performed fifty-four years before for gangrene after fever (Fig. 34).

Cancers in cicatrices mostly appear after this fashion, are usually epithelial, and are to be treated by the removal of the growth.

Fig. 52.

Congenital Cicatrix of Lip, Fissure of Nostril, and Contracted Eyelid.

Painful cicatrices are often due to the divided ends of the nerves being bound in by the cicatricial tissue, and as often as not they are caused by a bound-down bulbous growth at the extremity of a nerve. In a case I had some years ago the external popliteal nerve, as it wound round the head of the fibula, was so bound down by the cicatrix of a burn as to cause severe agony in the whole course of its distribution. The symptoms were relieved by two free vertical incisions through the cicatrix, and the patient recovered.

Should I ever see a similar case, I shall pursue the same course, except that I shall subsequently transplant pieces of skin in the wounds as soon as they assume a healthy appearance. When the pain is due to an adherent or bulbous nerve, the nerve must be freed and removed. When doubt as to its condition exists, Mr. Hancock's suggestion may be adopted, to divide subcutaneously the suspected nerve. Where no such causes as have been mentioned are to be made out, the case may be treated as one of neuralgia by full doses of quinine, arsenic, or iron, and local sedatives (the extract of stramonium or belladonna rubbed down with glycerine being a good application). Cases, however, of painful stumps or cicatrices are sometimes met with that defy treatment.

Congenital cicatrices are met with in practice. Thus, I have seen four patients, all females, with cicatrices in their upper lips, as if they had been operated upon for harelip (Fig. 52 was taken from one of them, and Fig. 188, Chapter XII., from another). In the former there was likewise a fissure of the nostril and a narrowing of the fissure of the eye. Bridles connecting the lip with the gum in an unusual manner are not uncommon.

ON SKIN-GRAFTING.

When John Hunter, a century ago, succeeded in transplanting the spur of a young chicken from its leg to its comb, as well as into the comb of a second bird, and found that it not only lived, but grew, he probably never dreamt in any flight of his genius that the fact which he then established would be so applied in the practice of surgery as to mark an era in its progress, and to bring a class of cases which surgeons were apt to look upon with little interest amongst the most curable and tractable of local affections. And yet this has come to pass, M. Reverdin of Geneva, on October 16, 1869, having succeeded in transplanting small portions of skin taken from one part of a man's body to the granulating surface of a large sore, under which treatment the ulcer healed. He read the case before the Surgical Society of Paris on December 15, 1869, and asked, "Is the growth of skin due to the effect of contact or neighborhood, or is it due to proliferation of the transplanted elements?"

Mr. G. D. Pollock of St. George's Hospital, encouraged by M. Reverdin's success, followed up the practice, and the good results he and his colleagues obtained soon induced all other surgeons to follow in their wake. The facts can be read in the *Transactions of the Clinical Society* for 1871, and at the present moment it may now be considered as a well-established practice.

Since its introduction I have very extensively carried it out, and in most instances with success. I look upon the suggestion as very valuable, its adoption rendering many cases curable that were not so previously, facilitating the cure of as many more, and giving interest to a class of patients in whom formerly there was but little. In the management of healing ulcers it is a great boon, while in the treatment of the large granulating surfaces so common after extensive burns its value cannot be overestimated. As an adjuvant to many plastic operations, more particularly on the face and in the case of deformities, it is invaluable.

Under the action originated by the transplanted fragments of skin, a process of repair goes on which at first appears almost magical: the grafts soon become islets of skin, round which cicatrization proceeds; the margin of the sore receives an impulse in cicatrization, which rapidly extends; and between the grafts themselves and the margin of the sore connecting links of new skin rapidly form, which divide the sore into sections (Figs. 53 and 54). By these means large surfaces speedily cicatrize which under former circumstances would have required many months.

Moreover, the contractions and subsequent deformities that under other conditions were too well known to follow in such cases do not occur.

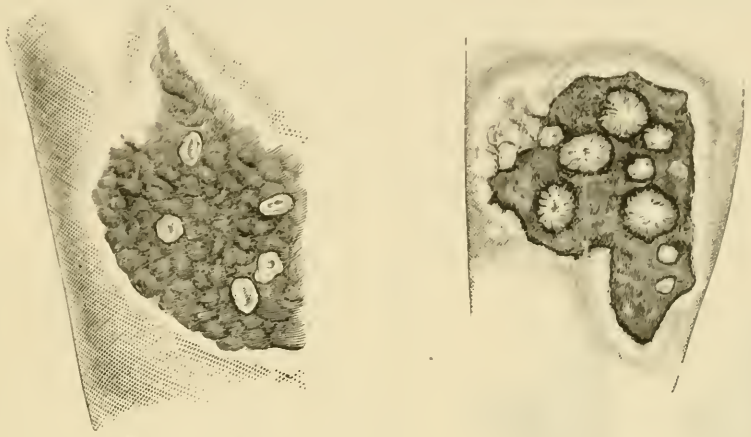
The practice seems applicable wherever a large granulating surface exists, and in its adoption the only desirable point to observe is that the *surface of the sore should be healthy*. This clinical fact includes another—that the patient's health is good, for there is no better barometer of health than a sore, its surface assuming a healthy or unhealthy appearance with every alteration in the general condition of the body. I have attempted, however, by way of experiment, to graft skin upon sores that were not quite healthy, and have sometimes succeeded. In some indolent sores in which a small patch of healthy granulations sprang up I have succeeded in securing by transplanting a new centre of "cutification," which proved of great value in aiding the healing process; in some others the graft has been enough to excite a more healthy action in the sore; still, in many, poor success followed the practice. It may, therefore, be accepted as a truth *that a*

healthy granulating surface is an important, although not an essential, requisite for success in skin-grafting.

Upon this basis I now proceed to consider how the operation is to be performed.

Pollock tells us that Reverdin's method is to remove a very minute portion of the skin, place it on the surface of the granulations, and there retain it with a strip of plaster. He writes: "I have usually removed the skin by nipping up a very small portion with a

Fig. 53. Fig. 54.



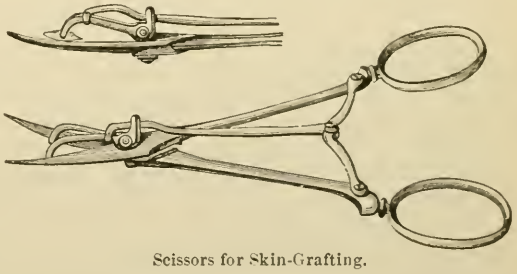
Drawings illustrating the Cicatrization of Sores by Skin-Grafting.

fine pair of forceps and cutting it off close with sharp scissors. At first I made a slight cut in the surface of the granulations and then embedded the piece of skin, but of late I have only laid it on the surface of the ulcer. I cannot say that I have found any difference in the result. I do not think there is great, if any, advantage to be gained by the transplantation of a large piece, but where the ulcer is large I think much is gained by the transplantation of numerous small pieces. The disadvantage of transplanting a large piece is the sore it creates; while the small sores formed by the removal of the minute pieces heal in a short time and without trouble" (*Clin. Soc. Trans.*, vol. iv.).

My own experience in every point confirms that of Pollock.

Mode of performing Transplantation.—For the removal of the sound skin I either employ a pair of scissors (here figured) which Messrs. Krohne made for me after Macleod's suggestion in a medical journal, or a fine lancet, after the elevation of the skin upon the point of a needle. I generally take the skin from the fore part of the arm or the side of the thorax.

Fig. 55.



Scissors for Skin-Grafting.

Having taken away the skin, the fragment should be cut into three, four, or more pieces, and these placed about *half an inch or three-quarters of an inch from the margin of the sore, and about one inch apart;* for there is no doubt that the engrafted centre has a stronger influence in exciting a healing action in the margin of the sore when placed near it than when isolated in the centre of a granulating surface.

The pieces should be placed upon the granulations and gently pressed in. There is no necessity to wound the granulating surface. They should be covered with a piece of oiled gutta-percha skin and the whole supported with cotton-wool, a bandage being subsequently applied so as to press moderately upon the part and keep the dressing in position. On the third day, but not before, the dressings may be removed with the greatest care, and a fresh piece of oiled gutta-percha skin should be subsequently applied.

The appearance of the engrafted pieces on the removal of the first dressing vary considerably. At times they will seem palpably to have taken root and be alive; at others to have disappeared altogether; whilst in a third class the surface of the cuticle will be

seen floating as a thin film upon the secretion of the sore, the basement membrane of the cuticle—the essential part—being left (Fig. 53).

Under all these circumstances, however, the surface of the sore is to be cleaned with the greatest care, a stream of tepid water from a dressing-can or squeezed from a sponge over the part being the best means to employ. The surface is on no account to be wiped, for the grafted portions of skin are easily uprooted, whilst those that seem to have died or that have disappeared often show themselves again later as "cutifying centres." As soon as the new centres are established in large sores other pieces should be engrafted, at about the same distance from the new pieces as those were originally inserted from the margin of the sore; and in this way the whole granulating surface may be speedily covered with new skin, and a rapid recovery follow.

How the engrafted pieces act in the healing process is now satisfactorily settled, for experience has proved that the grafts not only grow themselves by cell proliferation, but they stimulate the skin-forming powers of the margin of the sore, for as soon as the "grafts" have taken, the margin of the sore nearest to them is seen to cicatrize and to send out prolongations of new cicatrizing tissue to meet similar prolongations from the new cutifying centres, the sore in this way becoming subdivided by bands into smaller sores and then rapidly healing (Fig. 54).

FIG. 56. FIG. 57.

Drawings illustrating the Growth of Black Skin when Grafted on to the Sore of a White Man.

That the engrafted portions grow by the proliferation of their own cells is likewise proved by the fact that in the case of a white man upon whose granulating ulcer I engrafted four small pieces of black skin, the whole being no larger than a barley-corn, the black skin grew twenty-fold in ten weeks, to the extent illustrated in Fig. 56, the grafts subsequently enlarging and sending out prolongations which joined to form one patch of black skin (*vide* Fig. 57). The sore healed as rapidly where the black skin was grafted as where the white was placed.

The same result may likewise ensue when large pieces of skin are transplanted from the patient or from some recently amputated limb. But there seems to be no advantage in this practice, and in the cases in which it has been adopted a large proportion have failed. In a case of mine the grafts took root and excited a healthy action in the margin of the sore; they, however, grew but little, and remained on the cicatrix of the sore as bosses of skin with well-marked borders. They were grafted, it is true, but the grafts seemed to have no power of assimilating themselves to the tissues on which they were placed (*vide* model Guy's Mus.). When this practice is adopted, the pieces of skin, on removal, should be dropped into warm water in their passage to the wards where they are applied.

To take large pieces of skin from the patient's own body is an objectionable practice on account of the large wound it creates, and, moreover, is unnecessary in the majority of cases, as small pieces appear to do better. To take them from another subject is also objectionable for like reasons, but still more so from the risk that is necessarily run of introducing into the blood of the living subject some new or poisonous element—a risk to which I think a patient should not be subjected, and that I would not allow on myself. For these reasons I have forbidden my dressers adopting the practice.

In the case where black skin was transplanted I did it with the full concurrence of both patients; indeed, both were rather disappointed that the operation could not be repeated. They were firm friends, and the link I formed bound them closer!

There seems to be no objection to dividing the portion of integument which is to be employed into minute fragments—that is, into pieces the size of millet-seeds—the thumb-nail of the surgeon being the best table for the purpose. In children, where it is unadvisable to remove much healthy skin and the granulating surface to be covered is large, the plan is excellent, though I prefer pieces the size of half a hemp-seed, when they can be obtained. The practice of applying "skin-dust," or the products obtained by scraping the skin, cannot be recommended, as it is rarely successful.

Whether this newly-engrafted skin possesses the same power of resisting disintegrating

changes as the old skin is not yet proved. Some observations I have made lead me to suspect that it is in some cases rather liable to break down and ulcerate as soon as the patient begins to walk after the sore has completely healed, whilst in others I have found a sore in this way healed is more capable of resisting disintegrating changes than another healed by unassisted natural processes. At any rate, it is necessary to observe as much care in the after-treatment of the case as ought always to be observed after the cure of any other sore, and more particularly to afford moderate support and protection to the part. For this purpose there is nothing better than to bind on a piece of sheet-lead over the cicatrix when the seat of mischief is on the leg, as by it equal pressure as well as protection is afforded.

The new skin soon becomes as sensitive as the old; the sensibility of the cicatrix under these circumstances, indeed, seems to be greater than when unaided cicatrization is allowed to take place.

Sponge Grafting.

Dr. Hamilton of Edinburgh introduced this practice into surgery with a view of expediting the repair of deep wounds in which much loss of tissue has taken place, and he did so "thinking that sponge would imitate the interstices of the fibrinous network in a blood clot or in fibrinous lymph."[1] and that the blood vessels of the new surrounding tissues would push into these interstices and grow, and so fill up the cavity, the sponge eventually becoming absorbed. He gave cases which were apparently successful, and many have been recorded since.

To carry out the practice, a fine section of sponge should be applied to a healthy granulating surface and the sponge covered with oil silk. A layer of lint saturated with carbolic or terebene oil should then be applied, and the whole wrapped in some antiseptic gauze or boracic or salicylic wool. The dressing should be removed every second or third day, according to the quantity of discharge. The sponge is prepared by being steeped in diluted nitro-muriatic acid, to dissolve the silicious and calcareous salts, and later on washed in a solution of ammonia or potash, to remove all excess of acid. Before being applied it is purified by prolonged treatment with a five-per-cent. solution of carbolic acid. In the original paper Hamilton recommended thick sections of sponge; he now uses fine ones, fresh layers being consecutively applied as granulation tissue grows. I have employed sponge grafts on many occasions, and have seen more cases in which the practice has been carried out; and I can testify to the fact that the sponge becomes as it were incorporated with the granulation tissues, but whether it really expedites repair or not, or becomes of any practical value in the repair of deep wounds, I am not prepared to say.

Chilblains.

Chilblains are local inflammations of the skin, and are to be met with in subjects of a feeble circulation. They are more common in the young, and in women than in men, are generally seen on the toes, fingers, nose, or ears, and are caused by any sudden change of temperature or any sudden application of cold or warmth.

They show themselves as simple congestions of the skin attended with tenderness or itching; vesication of the skin, when the inflammation is more severe; or sloughing and ulceration of the skin, when a broken chilblain occurs. The disease may begin and stop at the first or congestive stage or run through all the stages.

Toward evening the symptoms of irritation are always increased, and any external warmth, as of a fire or bed, any full diet or stimulating drink, aggravates them: in fact, anything that excites the circulation in the part, at any hour of the day or night, is apt to increase the symptoms.

Treatment.—The local treatment of chilblains is no less important than the general, and more successful; for, whilst tonics, good diet, external warmth, and exercise are necessary to improve the general powers of the patient and the circulation, local stimulants are of great value. When the chilblain is not broken, the local application of the tincture of iodine, of a solution of sulphate of copper (three grains to the ounce), of camphor liniment, of soap liniment with opium or one-fourth part of the tincture of cantharides, of compound tincture of benzoin, or of simple spirit, not only gives comfort, but hastens the cure of the disease. The parts should also be covered with strapping spread on leather.

When the parts are broken, vaseline, boracic-acid ointment, with the use of thick lint

[1] *Edinburgh Med. Journ.*, Nov., 1881.

and oil silk or elastic tissue, are the safest remedies, stimulating lotions being used later when the parts are indolent in healing, such as terebene and oil or carbolic oil with opium.

Warm socks and loose shoes or boots are always indicated, but anything like pressure is most detrimental. Exercise also should be taken when possible, and an equable temperature ought to be maintained.

Frostbite.

It has already been shown that the sudden application of cold to any exposed part of the body of a feeble or depressed subject is liable to be followed by "*chilblain;*" and when concentrated cold is applied, under these circumstances, for a period sufficient to arrest the circulation in a part, a "*frostbite*" is the result. Sudden and severe alternations of heat and cold under exposure, even in healthy subjects, may produce this result; in military life this fact is well known.

The first effect of cold upon a part is a sense of numbness and weight with a feeling of tingling. To the eye the skin will probably appear redder than usual; and if the part be removed from the influence of the cold at this time, recovery, or in feeble subjects a superficial "*chilblain*," may follow. If the cold, however, be allowed to act longer, the parts will become stiff, and at last insensible, feeling "dead." To the eye they will assume a white and waxy aspect and be senseless to all impressions, the blood having been completely driven from the surface. When the cold has been suddenly applied and is sufficient to kill the structure outright, the frozen part will have a mottled aspect, from the retention of blood within the tissues. Many of these effects may be produced by the æther spray.

The *constitutional effects* of cold are at first stimulating, and subsequently depressing, excitement passing into sleepiness, and this into torpor. If the latter be yielded to, the sleep will end in death, the blood being sent from the surface of the body to the brain and other viscera, and death being produced by blood engorgement, as in apoplexy.

In the "sleepy and depressed stage" of cold, if the patient be brought suddenly under the influence of warmth and placed too near a fire, the risks of lung engorgement, as well as of rapid gangrene of the frozen parts, are very great; for by sudden reaction the arterial circulation becomes quickened when the parts gorged with blood have lost their power of propelling onward. In gangrene from frostbites there seems reason to believe that ulceration of the duodenum may follow, as after burns. Mr. Adams has recorded such a case in the *American Med. Times* for 1863.

Treatment.—Any sudden alternation of temperature being most injurious, the aim of the surgeon should be to recall the affected parts *gradually* to their normal condition —*firstly*, by assisting the venous circulation by gentle friction in the course of the veins with furs or flannel; and *secondly*, the arterial by comparative warmth applied externally and gentle stimulants administered internally. Neither warm water nor air nor fire should be allowed to approach the parts until the natural temperature has been partially restored, and then only with great care. Friction with snow or iced water is most useful. On reaction, the parts may be raised and lightly covered with flannel or cotton-wool or exposed to the warm air of a chamber; whilst food and stimulating drinks are carefully administered, warm milk with a little brandy being the best. Should reaction be too severe, it must be checked by lead or spirit lotions.

When gangrene follows—and it mostly does when the third degree of freezing, or the mottling stage, has been reached—and only *small* portions of the body suffer, such as the integument, the parts may be dressed by some stimulating application to hasten the separation of the slough, and should be kept warm. Carbolic acid and oil are probably the best applications; tonics should also be given.

When *large* portions of the body suffer, such as the whole foot (and in this country I have seen a coachman who had on new tight boots on a bitter winter day lose both feet), amputation may be called for, the surgeon always waiting till the line of demarcation or limit to the sloughing process is fairly marked.

Boils.

Boils are, in a measure, allied to carbuncles, and both are due to inflammation of the skin and subcutaneous tissue, though the disease probably commences in the latter. In both there is effusion of lymph into the areolar tissue of the part, and in both this generally sloughs, although in the boil the slough is local and confined to one central point,

while in carbuncle the process may cover an extent of integument varying from the size of half a crown to that of a plate.

Boils are met with in two forms—*one* as a subcutaneous affection attended with little pain until the skin over it inflames and suppurates. It then appears as a conical-pointed swelling, with inflamed indurated areola; this causes severe distress until the parts give way, when the feeling of tension and throbbing is followed by relief due to the termination of the sloughing process and discharge of the "core." When the slough has been discharged, an irregular orifice in the skin is seen covering in a cavity in the cellular tissue, which subsequently granulates, leaving a depressed and indurated cicatrix. The core or slough is composed of skin infiltrated with lymph.

The *second* form of boil begins as an inflamed follicle or pimple, which occasionally becomes vesicular and has a scarlet, exquisitely sensitive areola. It suppurates slowly, and, as a rule, terminates with a less well-marked slough than the former kind. Such boils are more usually multiple than the other, and are often caused by the application of moist dressings or of some cadaveric irritant.

Causes of Boils.—With respect to the *causes of boils* nothing definite can be laid down. That they are always associated with some debilitating or allied cause is belied by daily experience, for they are certainly often seen in men and women in whom no such condition exists, and in subjects who often declare that they "never felt better in their lives." As a rule, however, this is not the case, because they more commonly occur in subjects who have either been fed to excess or been subjected to some sudden change in the nature of their diet—such, for instance, as in men who undergo training for athletic pleasures, or who are subjected to the influence of fetid animal exhalations as met with in a skin-yard, pathological-room, or dissecting-room. They are seen also in the diabetic and cachectic subject, as well as in patients enfeebled by any fever or other debilitating cause. Gamgee tells us that they are often the result of eating diseased meat. They are also produced by the local contact of certain cadaveric emanations, the newly-appointed post-mortem clerks of our hospitals often falling victims, the poison acting at first as a direct irritant upon the follicles to which it is applied. They are far more common in some years than in others. In persons who are predisposed to their formation any local irritation is apt to produce them, such as the friction caused by rowing, the application of a poultice, water dressing, strapping, or a blister. They attack the integument of any part of the body, the palms of the hands and soles of the feet being apparent exceptions.

In the dense integument of the nape of the neck, buttock, and outside of the thighs they are more chronic and painful than in the skin of looser texture. They are troublesome local affections, but seldom endanger life. In rare instances they are followed by septicæmia and death, but only in one instance have I known this to occur.

Treatment.—The general treatment must depend upon the condition of the body and the apparent cause of the complaint, any unwholesome habit being corrected and any evident want supplied. Under other circumstances, the practice must be directed on general principles. The diet should be nutritious, but not too stimulating; exercise short of fatigue should always be allowed, and fresh air obtained when possible. The secretions should be looked to, and when out of order corrected, mild laxatives being often of service. When the skin is secreting unhealthily, the Turkish or warm bath is of great benefit. Moreover, alkalies or acids ought also to be given when the condition of the stomach needs them; alkalies and bitters are often of great benefit.

When debility exists, quinine is invaluable; and in London or large towns its combination with iron is required. When diabetes is present, the "full-feeding" treatment is probably the best. Dr. Jackson of the United States gives twelve to sixteen grains of quinine a day, increasing the dose daily until its special effects are produced, and then decreasing it. He continues the treatment for a month. Yeast in doses of a tablespoonful, taken fasting three times a day, occasionally appears to have a rapidly marked beneficial effect, although in what way it acts it is difficult to say.

The local treatment must be directed much by the local symptoms, it being, as a rule, a better course to let the boil discharge itself or dry up than to lance it. In the early stage of the papular or follicular form of boil the free application of alcohol, spirit of camphor, the nitrate of silver, liquor potassæ, or iodine tincture is often followed by its disappearance: but in the other kind all such applications are worse than useless. Covering up the areola of the boil with a perforated piece of plaster is a good practice. At times painting the areola with collodion or colloid styptic answers well.

When the pain is great from the tension of the part, and the areola of inflammation is

spreading, relief may generally be given by lancing; and when the slough is slow in separating, the introduction into the opening of a point of potassa fusa is followed by the rapid cleansing of the wound and its granulation. Poultices may be applied for a limited period during the sloughing stage, but not for any length of time, as they often encourage the appearance of others. When boils succeed one another *seriatim* without any definite cause, change of air is a most successful remedy.

Carbuncle.

This is a far more serious affection than a boil, for it is almost always met with in the feeble and cachectic subject, and generally in men, rich or poor, over forty-five. It is very frequently associated with diabetes, and gouty patients are particularly prone to its attack.

It generally occurs singly and is slow in its progress, the inflammation in the skin and cellular tissue beneath spreading as a brawny inflammatory effusion with no defined border. The redness of skin is rarely vivid, more frequently livid; at times the local pain is severe and constitutional depression very great. The sloughs separate slowly, many openings, as of many boils, allowing them to escape, and the whole skin at times separates as an ash-colored layer, leaving an irregular cavity undermining the neighboring tissues. The favorite seats of carbuncle are the skin and subcutaneous tissue of the nape of the neck, back, and buttock. They occur, however, on the front of the body and the extremities and on the lip or face. The disease is so slow in its progress as at times to occupy many weeks, one part going through its course while it spreads in another. It may destroy life by exhaustion or by pyæmia. The worst form of pyæmia arises from it; indeed, M. Labat (*Med.-Chir. Soc. Bordeaux*, 1868) believes pyæmia to be the most common cause of death in carbuncle. Rare cases have been recorded in which peritonitis was caused by the extension of the disease from the abdominal walls into the peritoneal cavity.

When the treatment by incision is adopted, life is too often shortened by loss of blood. As a general rule, however, carbuncle is not a fatal disease. Its danger depends much upon its extent, and more upon the complication with which it is associated.

Treatment.—In former days the one form of local treatment that every surgeon followed was that of the crucial incision, +, the knife being passed freely through the tissues to the base of the inflammatory effusion; the object of this was to give room for the slough to separate and come away. In modern times the value of this practice has been much questioned, for it was too often found to be followed by loss of blood where blood was much needed; nor has it been thought that the incision did much to hasten the progress of the case or the separation of the slough. It is still, however, a popular form of practice. I was taught it, but after observing its effects have long given it up, believing that it did little or no good and was often followed by a harmful hemorrhage.

The treatment I prefer, and have adopted for many years, has been that by caustic; and the more I see of it, the better I like it. It has been strongly advocated in this country by Pritchard, and in America by Dr. Physick. It is applicable in the stage of the disease when the cellular tissue is brawny and the early inflammation of the skin has subsided; it may be used before any openings in the skin are found, either, as Pritchard advises, by rubbing the caustic potash freely in the centre of the carbuncle until an eschar is fully formed, or, which is preferable, by puncturing with a scalpel and inserting the stick or a small piece the size of a pea well into the diseased tissues. When the carbuncle is large, many punctures may be made, one to every area of surface of the dimensions of half a crown. Where openings exist, the surgeon has only to insert the caustic and allow it to melt, either in the stick, or, what is better, in pea-like masses, by means of dressing forceps, passing them well down into the subcutaneous tissue. By this practice the slough is certainly cast off more readily than when incisions are made or the case left to nature. No bleeding takes place, and very little pain is given excepting at the time. With this treatment large carbuncles become soon healthy granulating wounds. The only care required is to prevent the caustic running over the sound skin. During this treatment a wad of absorbent cotton-wool should be applied, with some lotion, such as that of boracic acid, carbolic acid, or alcohol; a solution of opium applied to the part often gives relief to pain. Tonics, good living, and fresh air are also essential. The French surgeons prefer the use of the Vienna paste. Paget prefers the common resin cerate. By these means, unless the carbuncle is associated with some serious malady, such as diabetes or pyæmia, a good result may be looked for.

The plan of making a subcutaneous incision has been ably advocated by Mr. French and M. Guérin, and that of compression by Messrs. O'Ferrall and M. H. Colles of Dublin (*Dub. Quart. Jour.*, 1864). The former plan I have tried, but have failed to find its advantage. The latter I have not employed, having been already well satisfied with the caustic treatment.

Facial Carbuncle.

This has been often miscalled "malignant pustule," to which attention has been drawn (p. 108). It was probably first described by a clever young surgeon, Harvey Ludlow (*Med. Times and Gaz.*, September, 1852). It is generally found on the lip, the upper one being the more commonly involved, as an œdematous inflammatory swelling of the part, involving the nose and cheek, often preceded by some pustule or vesicle, and generally accompanied by them. It is almost always associated with severe pain. It ends, as do most cases of carbuncle, with sloughing, and at times the whole substance of the lip or cheek gives way. It is associated, like carbuncle, with great constitutional depression, and its special danger is thrombosis and phlebitis of the cerebral sinuses; the inflammation of the veins extends from the affected parts through the ophthalmic veins to the cavernous sinus. I have seen six cases at least of this affection—four of the upper and two of the lower lip—and all recovered. In only one did the disease extend beyond the lip, while in all the disease, as far as local treatment was concerned, was left to natural processes, cleanliness and fomentations being alone employed. Tonics and good diet were given, and quinine with iron, in full doses, appeared the best. Paget advises quinine in sufficient doses to produce symptoms of cinchonism.

M. Reverdin of Geneva gives a very elaborate essay on this subject in the *Archives Générales de Médecine*, 1870. At p. 162 of the August number he thus sums up his conclusions:

1. Anthrax and furuncle of the face present a special gravity.
2. This gravity is due to the ready complication with phlebitis.
3. The facial phlebitis is attended with death, either by extension to the sinuses of the dura mater or by becoming the source of purulent infection.
4. Of anthrax of the face, that of the lips is more frequently complicated with phlebitis than the others. This may be explained by the peculiar texture of the lips.
5. Anthrax of the lips has nothing in common with malignant pustule.
6. The involving of the orbit in the phlebitis, as demonstrated by exophthalmia, shows almost for certain the implication of the sinus.
7. Incision, speedily and extensively performed, seems to be the best means of preventing, and sometimes of arresting, the phlebitic complications.

Perforating Ulcer of the Foot.

This affection was so called by Vesigné of Abbeville in 1850. It is an affection which Mr. Hancock brought prominently before us in an able paper published in the *Brit. Med. Journal*, June 26, 1869, although Cloquet, Boyer, and Nélaton, of Paris, have also described it. Nélaton says it "commences with phlyctæna in the pad of the foot. The epidermis is raised by a small quantity of purulent serum. Others describe it as commencing like a flat corn, which ulcerates. When this is opened the subjacent dermis appears of a rose color, and when touched is highly sensitive. This state may continue for some time, when the dermis in its turn gradually ulcerates, and a small fistulous opening is established in the subcutaneous cellular tissue, which will not heal, but continues to discharge serum slightly tinged with pus. If after five or six weeks the sinus is examined by a probe, the subjacent bone is felt rough and necrosed, and a sequestrum subsequently forms." An attempt has been made[1] to connect this local affection with nerve lesion, central or peripheral; but evidence is still wanting to prove that there is more than an accidental connection between the two conditions.

Treatment.—The disease is most obstinate in its character, generally spreading over years. It is, however, chiefly local and confined to the anterior portion of the foot. Medicine has little power over it; Fowler's solution has been much vaunted for its cure, but with insufficient evidence; and, as far as facts can guide us, it appears Hancock's conclusion—that when dead bone exists it should be removed—is the only right one. "But if, notwithstanding, the disease returns, there can no longer be a question that, when once perforating ulcer of the sole of the foot is established and recognized, it is

[1] Savory, *Med. Chir. Trans.*, vol. lxii., 1879.

better at once to remove the whole of the metatarsal bones either by Chopart's, Syme's, or Pirogoff's amputation."

These cases are not to be confused with the suppurating bursæ or bunions found in feet deformed from short or tight boots.

Delhi or Oriental Sore.

This disease, which is identical with the Moultan sore, Aleppo boil, or Biskra bouton, "yaws of the West Indies," and Parange of Ceylon, is a cutaneous disease due to the entrance of a parasite into the body, during bathing or washing, through an opening in the cuticle caused by an abrasion of the skin, such as a mosquito-bite. The parasite is supposed by Messrs. Alcock and Fleming of the Indian army (*Med. Rep.*, 1868) to dwell in the foul, brackish, hard well-water (the Delhi well-water containing 45 to 50 grains of carbonate of lime per gallon). Such good observers as Messrs. Lewis and Cunningham (*Appendix to 12th Report of Sanitary Commissioners with Government of India*) assert, however, that the disease is of the nature of a lupus and should be treated as such. Indeed, they describe it as "lupus endemicus" (*Lancet*, April 7, 1877). It may attack dogs and horses. "It appears on the exposed parts of the body, at first as a small pimple, like an irritated mosquito-bite, and remains in this state for several days or weeks, sometimes for months. It then slowly increases, and a thin fluid escapes from the top, which dries and forms a circular scab, gradually increasing in size and thickness. When this scab is removed, an indolent ulcer is exposed, with undermined edges and lobulated granulations in the centre, in healthy subjects like raspberries, but paler and more blue in cachectic cases. These ulcers, when very broad, show signs of cicatrizing from the centre; in all there remains a depressed cicatrix after healing. The disease may last from six months to two years" (Surgeon-Gen. Murray, Epidem. Society, March, 1862).

Treatment.—It is to be treated by personal cleanliness, the avoidance of the use of foul *hard* water, the early destruction of the sore by the cautery or caustic, and the application of metallic astringents. Tonic treatment, a good diet, and if possible change of locality and climate, should be secured.

Mycetoma, or the Fungus Disease of India.

This disease has been described by Dr. Carter of Bombay in the *Trans. of the Med. and Phys. Soc.*, Bombay, 1861, and in a memoir published by Churchill, 1874, and it is supposed by him to be due to the presence of a fungus. Other authors have thrown doubt upon this point, and amongst them F. B. Lewis and D. Cunningham of Calcutta, who conclude that it is reasonable to infer that localized spots in the tissues undergo degenerative changes into a substance peculiarly adapted to the development of filamentous growths. The origin of the fungus in situations where no spore could penetrate must remain a matter of perplexity (M. J. Berkeley, *Nature*, November 9, 1876). The disease, however, is well recognized. Berkeley observes that the bodies found in the disease "so nearly simulate fungous growths that it is difficult to get rid of the notion that they are really vegetable growths" (*Intellect. Observ.*, 1863). The disease is more frequent in men than in women, and affects all classes, rich as well as poor; but it has never attacked an European.

The disease is chronic and affects most commonly the foot, sometimes the hand, and but rarely other parts of the body. It is very slow in its progress and has no tendency to get well if left alone. Usually it begins on the plantar surface of the foot or the palmar of the hand, as an induration in or under the skin; this subsequently softens down; a bleb then forms over the spot and bursts, leaving a sinuous opening, from which exudes a thin, sanious, sero-purulent discharge. As the disease progresses other indurations, followed by sinuses, form, till the foot or hand becomes one indurated diseased mass riddled with holes, the orifices of sinuses, which may or may not lead to bone; and in extreme cases the bones are tunnelled. These sinuses discharge freely a putrid sero-purulent fluid containing "fungus particles." The fungi are of two kinds, each, according to Dr. Carter, marking a variety of the disease. One, the dark or dark-brown, is globular or ovoid in form, hard and friable in consistence, and of the size varying from a pin's head to that of a bullet. The other is pale or yellowish in color, soft and cheesy in consistence, and of the size of a minute speck or pea. Dr. Carter and others believe that excision or amputation of the affected part is the only sound practice to be adopted.

Warts.

These are outgrowths of the papillæ of the skin, the papillæ being usually elongated and their epithelial covering thickened. They are common on the hands and other parts of the body of the young, and more rare in the adult. When on exposed parts of the body, they assume a horny hardness; but when surrounded with moisture or the secretion of the skin, they are soft and more sensitive.

The flat wart is called *verruca simplex*; the pedunculated, *verruca digitata*; and these are said to be more common in the scalp. I have seen them on the neck, orifice of the nose, mouth, eyes, ears, and anus, also on the prepuce and labia. I have seen them also on the tongue. They occur at times beneath the nails and are very painful—*sub-ungual*. The worst crop of warts I ever saw was around the anus of a boy.

The flat warts occasionally come and go in a way which cannot be accounted for; as a rule, they are, however, persistent. They rarely last into adult life; but when they do, they seldom grow or give trouble. In exceptional cases, under some local irritation, they may increase and assume more the character of an epithelial cancer. When on the face, this change is peculiarly liable to occur. Not long ago I destroyed an epithelial cancer by the ala of the nose, the size of a florin, that had suddenly appeared in a wart which had existed for sixty years—nearly all the patient's life; and I have removed from the lip of a man a cancer that had grown from a wart which had existed as long as he could remember.

Venereal warts are very abundant, whether they grow from the glans penis or prepuce of the male or labia of the female. They are pedunculated, moist, and highly vascular, and are clearly contagious. Warts, however, may occur at times in these parts without any venereal contact.

Treatment.—Some powerful alkali, such as ammonia, to dissolve the cuticle, and the subsequent application of the glacial acetic acid, nitric acid, or acid nitrate of mercury, to destroy the papillæ, is the best plan to get rid of the harder or flat warts. Lunar caustic is an unsatisfactory and tedious remedy. Pedunculated *dry* warts should be cut off with the knife or scissors, and the *moist* may be treated in the same way when not too extensive. When, however, they are extensive, they may be made to dry up by the application of some powder, such as the oxide of zinc, or even starch. Powdered fresh savine is a good application; Mr. T. Smith recommends it to be mixed with the powdered diacetate of copper. The perchloride of iron in tincture is also serviceable. Venereal warts and others, when extensive, may be readily destroyed by means of the galvanic cautery, the patient being under chloroform. At times excision is the best practice. In the large masses that are found on the genital organs of women, of venereal origin, nothing but the removal of the whole with the labium can be entertained; when the écraseur of the galvanic cautery cannot be obtained, the ordinary wire instrument may be used. The hemorrhage from these venereal warts is generally severe, and the surgeon should never attempt to remove them by excision, when they are extensive, without having at hand some good styptic, such as the solution of the perchloride of iron, matico, alum dry and in solution, or the cautery in one of its forms.

Moles.

Using the word in the broad sense to include small spots of discolored skin, and cutaneous connective-tissue tumors with pigment, with or without unnatural growth of hair or skin glands, they are very common, few people being without one or more upon the surface of the body, while many have them in numbers. I have seen a woman studded all over with hairy moles, the hairs having been in some half an inch long and bristly. Moles are generally congenital, but at times put in an appearance later in life; they are rarely of any great importance beyond the disfigurement they produce. Occasionally, however, they degenerate or become the seat of a cancerous disease; the melanotic sarcoma has frequently its origin in such congenital spots. This clinical fact, which is now fairly recognized, is important, and renders it expedient for the surgeon to excise any mole that has a tendency to grow or to become indurated in middle life. Many of the most virulent forms of multiple cancer the surgeon sees have their origin in moles.

Corns.

These are thickened cuticle, the result of *occasional pressure*, whether on the toes or feet, from tight or hard boots, or on the hands, from the mechanical irritation of tools, etc.,

or elsewhere. It should be remembered that they are the result of occasional, and not constant, pressure, the latter causing atrophy and absorption. "Not only," wrote Hunter, "the cuticle thickens, but the parts underneath; and a sacculus (bursa) is often formed at the root of the great toe, between the cutis and ligaments of the joint, to guard the ligaments below." This bursa is found under all corns when the pressure is not removed. A corn, when newly formed, can by maceration be elevated from its position as thickened cuticle only, the cutis being unaffected; but in old corns the cutis appears to atrophy and the papillæ to disappear. Such corns, writes Mr. T. Smith (*Holmes's Syst.*, vol. v.), "may be found based upon the fibrous tissue of the sheaths of the extensor tendons of the toes, all intermediate structures having been absorbed." When a bursa has formed, it may inflame or suppurate and give rise to troublesome conditions such as will be described under "Bunion."

A corn is called "soft" when it forms between the toes. It is far more painful and sensitive than the "hard;" it grows also more rapidly, probably owing to its greater moisture.

Treatment.—Remove the cause and the disease will disappear. This is a doctrine which applies to corns of all forms when acted upon early. Boots which are too loose are as injurious as those which are too tight: where one presses the other rubs, the result being the same. A well-fitting boot with a broad sole, *straight inner border*, and square top is the best. To remove the cuticle nothing equals warm water; and after soaking the part in it for some time, or keeping the corn covered for a night or more with water dressing and oiled silk, the whole may be carefully peeled off by means of a knife. After the removal of the corn the skin should be protected by a piece of soap plaster spread on leather. The application of nitrate of silver has been recommended, but I have known it produce great pain, and when applied to an inflamed corn much harm—indeed, in one case, sloughing of part of the integuments covering the little toe. In old people it is dangerous. The application of the glacial acetic acid is to be preferred. When suppuration takes place beneath a corn, it should be relieved by a puncture as soon as possible, and water dressing applied. Bursal swellings are to be treated as bunions. Soft corns are best treated by taking away pressure by means of the introduction between the toes of absorbent cotton-wool and the use of some dry powder, such as the oxide of zinc; the corn thus soon becomes a dry one and is easily eradicated. Acetic or carbolic acid is a good application in obstinate cases.

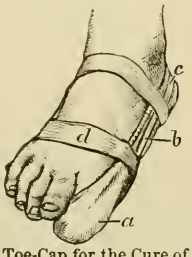
Bunions.

When from excessive or long-continued pressure a bursa forms over one of the tarsal or metatarsal articulations, a "bunion" is said to be present; and the most common seat for this affection is the metatarsal joint of the great or little toe. This fact is to be explained by the evil tendency which boots, as generally made, have to draw the toes together toward the central line of the foot, the central axis of the undeformed great toe, which runs parallel with the metatarsal bone through the centre of the heel, being thus made to deviate from the normal to an abnormal line, in which the great toe itself, looking outward, forms with the metatarsal bone at the joint an angle pointing inward, and the axis of the toe falls far within the normal one of the foot (Fig. 58).

Fig. 58.

Bunion.

Fig. 59.



Toe-Cap for the Cure of Bunion.

Aston Key,[1] however, attributes this deformity more to excessive weight received on a weak tarsus and metatarsus from over-standing, the great toe being gradually forced outward by the oblique bearing of the foot on its inner plantar surface when the arch of the foot has given and the foot becomes flat. Too short boots greatly favor this change, the foot by such being compressed longitudinally and the arch of the tarsus increased, the toes even being drawn up to form angles with the metatarsal bones, the great toe suffering the most. When bursæ form over the projecting bones, it is to save the joints from injury; and at times these form over the dorsum itself. Under extreme conditions the bursa may inflame and suppurate, giving rise to obstinate and troublesome sores. In still more extreme or neglected cases the joint of the great toe may be involved, ending in its destruction with or without exfoliation of bone.

[1] *Guy's Hosp. Rep.*, 1836.

Treatment.—When the nature of a bunion is understood, the principles of its treatment become clear. Preventive treatment is the best, and consists in maintaining the natural condition of the foot; in young children, and in girls especially, by guarding against the flattening of the foot from over-standing or walking during the period of growth, and against altering the axis of the great toe by keeping the inner line of the boot straight; and in no way by too short boots cramping the foot longitudinally.

When a bunion has formed, the only consistent treatment is that which tends to restore the misplaced toes to their natural position—when the great toe is involved, either by Key's plan of having a separate compartment made in the boot, so constructed as to keep it in a straight line with the foot, or by the simple apparatus given in Sayre's work on orthopædic surgery (Fig. 59), which consists of buckskin or linen caps to the toe (*a*), a few inches of elastic webbing (*b*), a piece of adhesive plaster to go round the foot (*c*), and two circular pieces of the same (*d*) to retain all in position. Even in severe cases this practice may be successful, and in the old and confirmed cases the same is to be adopted; palliative treatment, however, is at times alone practicable.

The common plan, wrote Key in 1836 (*Guy's Hosp. Rep.*), "resorted to for the relief of bunion palliates the evil in some degree by removing the pain and taking off the pressure, but it does not go to the root of the evil. The plasters on thick soft leather are agreeable to a painful bunion by keeping the skin in a pliant state and by protecting the part from pressure," but they do not cure the disease.

Under all circumstances, pressure is to be removed; nothing like a tight boot ought to be thought of, a wide and easy one being worn. To the inflamed bunion water dressing is the best application. Should suppuration take place, an early incision into the bursa should be made. In old people, however, some caution is called for in carrying out this practice, because in such, where from diseased arteries or other causes the circulation is feeble, gangrene of the part or a troublesome suppuration may arise. When suppurating sores exist, they may in the aged require stimulating applications; in the middle-aged, the bursa may be laid open and allowed to granulate or be excised. In the early stage of a bunion the mechanical means suggested may be aided by the local application of a small blister, and Mr. Thomas Smith speaks highly of the local use of the biniodide of mercury ten grains to an ounce of lard (*Holmes's Syst.*, vol. ii. p. 938, 3d edition).

In the last stage, when the joint is destroyed, the case may have to be treated by incision of the parts, excision, or even amputation.

In-Grown Toe-Nail.

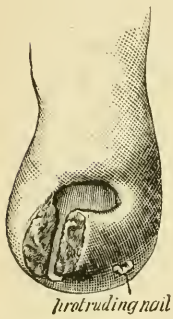
This is a troublesome and painful affection, and is more commonly met with on the outer side of the great toe-nail than on the inner, though it may occur in both places. It is usually caused by external pressure upon the soft parts, the movable soft parts being pressed upon the immovable nail. As often as not it is due to the collection of cuticle beneath the edge of the nail, this cuticle acting as a foreign body and by its pressure causing ulceration. Ulceration having once been set up, the healing process is prevented by the presence of this cuticle, together with the pressure of the edge of the nail and the soft parts covering it in; fungous granulations, as a consequence, frequently form, and copious discharge takes place, the affection being attended with severe pain.

Treatment.—The disease being the result of pressure applied from without in the shape of tight boots, or from within in the form of indurated cuticle beneath the nail, the surgeon's main object in the treatment is to take away the exciting cause, and when the collection of cuticle exists, by the careful introduction of a probe beneath the nail, to procure the evulsion of the foreign body. In the early stages of the disease this treatment is often sufficient. When external pressure has been the cause and ulceration exists, the soft parts may be carefully pressed away from the sharp edge of the nail by the careful introduction beneath the overhanging integument of a small roll of lint, which should be well pressed down to the bottom of the sore and fixed in position by means of strapping, applied so as to draw the soft parts away from the nail. This treatment, by removing all pressure from the sore, as a rule, is successful. When the fungous granulations are excessive and the discharge is profuse, the free use of the powdered nitrate of lead before the application of the lint is of great value. After one or two applications of the lint in the manner described, the soft parts will have been so pressed to one side as to expose the edge of the nail with the surface of the sore, when the lint or a piece of thin sheet lead or tinfoil may be introduced beneath the edge of the nail and the dressings renewed. By this treatment a rapid cure readily ensues; and if no external

pressure be reapplied and the nail is allowed to grow up in its normal square form, there will be no recurrence. In severe cases, where the soft parts so overhang the nail as to be unaffected by the means here suggested, or where the nail perforates the soft parts (Fig. 60), the best course is to excise the overhanging integument by means of a scalpel; the ulcer by this method is exposed, and the sore during the process of cicatrization so contracts as to draw the soft parts away from the nail, which will then grow up in its normal form and act as a covering to the toe.

When the ulcer has spread far under the nail, it may be expedient to remove a portion of the latter to allow of cicatrization, though, in a general way, to remove half the nail, to take away a V-piece from the central part of its edge, to scrape or notch it, are only temporary remedies. They may succeed for a time and allow the sore to heal, but it is certain to recur in all severity as soon as nature has restored the parts which the surgeon has removed.

Fig. 60.



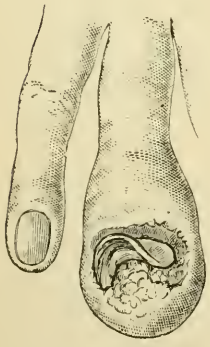
Protruding nail

To cut the corner of the nail under the idea that it is the offending body is a futile proceeding; it may for the moment appear to be of service, but in the end it is injurious. Indeed, the nail should be left square, as nature made it, and care should be taken to see that the soft parts are in no way pressed over its edge.

Onychia Maligna.

This is a disease of the nail matrix, and a far more severe and obstinate affection than the last. It is found most commonly in unhealthy children, and, as a rule, is started by some local injury, such as a squeeze. It commences as a swelling of the end of the toe or finger, with the other external signs of inflammation—redness, heat, and pain. These symptoms are soon followed by the exudation from beneath the nail of a serous and often fetid fluid; the nail itself loosens, sometimes falls off, or either flattens out or curls up at its edges (Fig. 61). When this occurs, a foul ulcer is visible beneath. In extreme cases the affected parts assume a flattened bulbous form and look as incurable as any local affection can well appear, and in rare instances the disease involves the last phalangeal joint or bone. It is never found in other than feeble and cachectic children. The worst case of this nature I have seen occurred in a child æt. 10, in whom the fingers and thumbs of both hands were involved; and the disease had existed for years.

Fig. 61.



Acute Onychia.

Fig. 62.

Chronic Onychia.

Treatment.—In favorable and not extreme examples of this affection tonics internally and water dressing externally suffice to bring about a cure; while in others more active local treatment is called for, such as the application of some mercurial lotion, as black-wash or Abernethy's lotion (formed of the liquor potassæ arsenitis ℥ij to ℥j of water) or the red-oxide-of-mercury ointment. In the case to which I have already alluded all this treatment failed, even after the evulsion of the nails—a plan of treatment that should always be adopted in obstinate cases. The cure was at last effected by making a clean shave of the dorsal aspect of the extreme phalanx, taking away nail and soft parts. This course was resorted to only after the disease had existed for five or six years and had resisted every form of treatment, even to the repeated evulsion of the nails, the pain being agonizing and demanding surgical interference. Fig. 61 was taken from one of the fingers of this patient. Professor Vanzetti of Padua strongly advocates the application of the powdered nitrate of lead to the ulcer, and my own experience of its value justifies me in strongly recommending it. Constitutional treatment, with tonic regimen, is always necessary.

The disease may at times have a syphilitic origin, when it will be wise to adopt specific treatment.

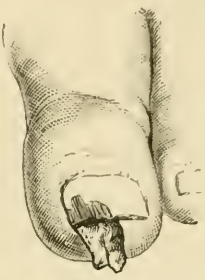
Other Diseases of the Nails.

Under the influence of some acute diseases, the nails cease to grow, and the arrest becomes manifest, as convalescence advances, by a transverse groove in the nail, while the width of the groove denotes the duration of the arrested growth.

Ridged Nails.—As a result of hereditary syphilis Mr. Hutchinson has shown that the nails may become completely ridged, while even in acquired syphilis Hutchinson, Wilks, and Fagge have fairly proved that the nails may become narrow, thick, ill-formed bodies, or concave, rough, and black.

Psoriasis affects the nails somewhat in the same way, the nail thickening and splitting vertically; and in *favus* Fagge has shown that the nails may become thickened and of a yellow color from the interstitial deposit of the parasitic disease. Wilks in the *Lancet* for 1868, and Fagge in *Guy's Hosp. Rep.*, 1869–70, have written fully on these points. At times the nails become soft and in feeble subjects very convex. This condition is said to be common in phthisical subjects, but in surgical disease I have often observed the same condition appear during illness and disappear as strength returned. I regard it only as an evidence of feeble power.

Fig. 63.



Horny Growth from beneath Nail.

Fig. 64.

Ungual Exostosis.

Horny growths occasionally spring up beneath the nail, as seen in Fig. 63, and **ungual exostosis**—which is a bony outgrowth from the extreme phalanx of the great or other toe—very frequently appears as seen in Fig. 64. Both require excision.

ELEPHANTIASIS.

This term has been applied to two very different diseases—the *Elephantiasis Græcorum, or true leprosy*, and the *Elephantiasis Arabum, or Cochin or Barbadoes leg.* The former is probably constitutional and appears as a tubercular affection of the skin, more especially of the face, attended with some loss of sensation; it is usually ushered in with slight febrile disturbance and local œdema. As it advances the skin thickens and the tubercles multiply; the disease spreads and involves the tongue, mouth, nose, eyes, and even larynx and lungs. In extreme cases ulceration and disease of the bones exist, the subjects of the affection dying from exhaustion if not from suffocation. It is, happily, rare in this country, although it does occur occasionally; it is, however, common in Norway, in the Mediterranean, and in the Indies. Dr. Webster in the *Med.-Chir. Trans.* for 1854, and Mr. Day in the *Madras Quart. Journal* for 1860, give valuable information upon the subject; and Dr. Carter in the *Trans. Med. and Phys. Society of Bombay*, vol. viii., new series, enters fully into its pathology.

The disease has been regarded as incurable, although, since the introduction in 1873 of the Gurjun or wood oil by Dr. Dougall of the Indian medical service, better results of its treatment have been realized. The oil is used as an external application, made into an emulsion with lime water, in the proportion of one part to three, and should be well rubbed in twice a day for two hours at a time. It has also to be taken internally in two-drachm doses mixed with the same quantity of lime water twice a day. With this treatment the tubercles are said to soften down, and in their place watery blebs form, which burst and discharge a clear serous fluid, and then the induration gradually subsides. The oil taken internally is a diuretic and purgative.

Elephas.

To the surgeon the second form of elephantiasis, or the *Elephantiasis Arabum*, is of the greatest interest. It is quite distinct from the true leprosy. It appears generally in one or other of the lower extremities or in the male or female genital organs. It shows itself as a general infiltration into the skin and subcutaneous tissue of an organizable material, whereby the integument becomes hypertrophied and greatly thickened. It is commonly associated with some enlargement of the lymphatic glands, and frequently with dilatation of the lymphatics. It is occasionally associated with chyluria. In advanced

disease the skin falls into great folds, and between these fissures form, which subsequently pass into oozing ulcers. At times the foot and leg become the seat of extensive ulceration, which rarely cicatrizes.

It generally begins with some febrile attack, and the affected part becomes the seat of erythematous redness and swelling, which subside, again to recur; each attack leaves some extra thickening behind it. I have observed this very clearly in many cases, and have no doubt that the erythema had some distinct relation to the disease.

Treatment.—Dr. Wise of Calcutta in 1835 looked upon elephas as a disease of the venous system and inflammatory. Mr. Day, in the paper already alluded to, regards it as consecutive to malarious fever, while Mr. Dalton (*Lancet*, 1846) looks upon it as a constitutional disease, like the leprosy; and upon this theory the sciatic nerve of the affected limb has been resected by Dr. J. S. Morton of Pennsylvania with some success. Dr. Carnochan of New York believes it to be associated with an enlargement of the arterial trunks of the part, and upon this theory based his practice of tying the main artery of the limb, thereby starving the disease. He performed this operation for the first time (in January, 1851), and the success he met with, as published in a memoir on the subject in 1858, induced me to follow his example in 1865. My case in all its details was published in the *Med.-Chir. Trans.*, 1866, and the benefit of the operation was most striking. It occurred in the case of a Welsh girl æt. 25; the disease had been of two years' standing and was spreading. The thigh of the affected limb (Fig. 65) measured twenty-seven inches round and the leg nearly twenty-three, the affected leg being nine inches in circumference larger than the sound one, and the thigh seven. Five weeks after the ligature of the external iliac artery the calf of the affected limb measured seven inches less than it did at the time of operation; and when she left the hospital, the limb appeared as in Fig. 66. The rapid disappearance of the thickened tissue was very remarkable. Since the operation the girl has gone on well, is companion to a lady, and can now walk ten or twelve miles. The limb becomes slightly œdematous only on over-exertion.

Fig. 65.

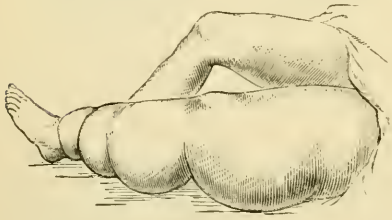
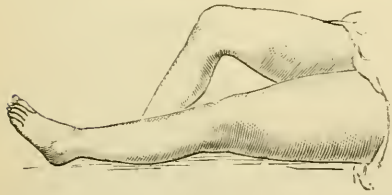


Fig. 66.



Case of Elephantiasis Arabum before and after the Application of a Ligature to the Femoral Artery.

I have performed the same operation three times since, but not with similar success. I ligatured the femoral artery of a man who had the whole limb involved, the thigh being only slightly so, and for a time everything promised to be as successful as in the case previously recorded; but an attack of erythema came on, followed by renewed swelling of the extremity, which never disappeared. In this case the size of the superficial femoral artery was extraordinary, the loop of the silk ligature when it came away being capable of admitting a No. 12 catheter. The vessel seemed to be nearly the diameter of my finger and was very thick. In a more recent case, however, gangrene of the foot, followed by death, took place.

When this operation is performed, the vessel should be ligatured well above the disease. I may add that Butcher in 1863 and Alcock in 1866 had successful cases, though Sir Joseph Fayrer and Buchanan of Glasgow have not met with successful results.

When surgical interference of this kind is not applicable, elevation of the affected limb or pressure should be employed. In severe cases amputation may be called for.

On three occasions I have had to circumcise patients with elephas of the penis and scrotum, and in each after the operation the whole of the thickening of the scrotum disappeared. This fact is worthy of record.

Pathology.—Within recent times an opinion has gained ground that the true pathology of this elephantoid disease is to be found in the lymphatics and that it is due to lymphatic obstruction. It has, moreover, been thought by Dr. T. Lewis that the presence of the *Filaria sanguinis hominis* might have something to do with it, since the parasite has been found in the blood of patients who have had elephas.

In support of this view a very striking paper has recently been published by Dr. Patrick Manson in the *China Customs Gazette, Medical Report*, for the six months ending March, 1882, an abstract of which may be read in *Med. Times and Gazette*, Feb. 12, 1883.

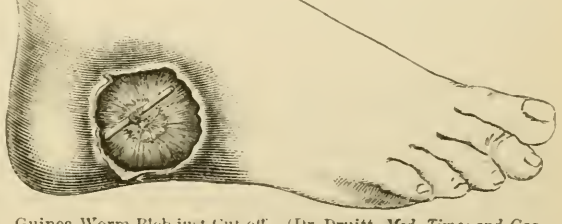
"In the instances," writes Manson, "in which the parent worm has been discovered, she was found in lymphatic vessels on the distal side of the glands. This has been shown to be in many, if not in all, cases her normal habitat. Her progeny, therefore, must travel along the afferent vessels, through the glands, and so on to the thoracic duct, and thence into the blood. The long, sinuous, and powerful body of the embryo is well adapted to perform this journey. But suppose, instead of this mature embryo, an ovum is launched into the lymph-stream prematurely and before the contained embryo has sufficiently extended its chorion; then this passive ovum must certainly be arrested at the first lymphatic gland to which it is carried by the advancing lymph-current. It measures $\frac{1}{750}''$ × $\frac{1}{500}''$, whereas the outstretched embryo is only about $\frac{1}{3000}''$ in diameter. It is much too large to pass the glands, and the embryo, rolled up in its chorional envelope, cannot aid itself. It becomes, in fact, an embolus. Now, filariæ are prodigiously prolific. Myriads of young are expelled in a very short time. I have watched the process of parturition in the minute *Filaria corci torquati*. Every few seconds a peristaltic contraction, beginning low down in the uterine horns and extending to the vagina, expels some twenty or thirty embryos. If this process of parturition occurs prematurely, or peristalsis is too vigorous and extends to a point high up in the uterine horns where the embryo has not yet completely stretched its chorional envelope, then ova are expelled. These, as they reach the glands, where the afferent lymphatic breaks up into fine capillary vessels, act as emboli and plug up the lymph-channels one after another until the fluid that carries them can no longer pass. In this way the gland or glands directly connected with the lymphatic in which the aborting female is lodged are thoroughly obstructed. Anastomoses for a time will aid the passage of lymph, but the anastomosing vessels will carry the embolic ova as well as the lymph. The corresponding glands will then in their turn be invaded, and so on until the entire lymphatic system connected directly or indirectly with the vessel in which the parent worm is lodged becomes obstructed." The degree of embolism and location of the worm determine the site and character of the resultant disease.

ON PARASITES.

Guinea-Worm.—The *Dracunculus* or *Filaria medinensis* is one of the most troublesome parasites known in Africa, Asia, India, and tropical America. In Europe it is only occasionally met with in those who have visited the above districts.

The mature worm varies in length from two to six feet. It is cylindrical in form, white in color, has a smooth surface, is tough and elastic; its mouth appears as a circular orifice and it has no anus. How it enters the body is unknown, although it is evident that it does so from without, and probably through the skin of some part that has been in contact with water, inasmuch as it is more common in the feet than in other parts of the body, although the Madras water-carriers are said to have them in the back. At any rate, the worm gets into the subcutaneous areolar tissue, where it remains. Busk tells us that it does so usually for about twelve months, although it may be eighteen. When mature and the time has come for the discharge of the embryos with which it is filled, it makes its presence known by boring the skin, protruding its head under the cuticle, raising a bleb, and coming out bodily, discharging its young filariæ externally.

FIG. 67.



Guinea-Worm Bleb just Cut off. (Dr. Druitt, *Med. Times and Gaz.*, January 3, 1874.)

TREATMENT.—The first manifestation of the disease is usually a circular bleb, as represented in Fig. 67, although it often happens that pain and stiffness of the affected part have been complained of for some time previously. The bleb contains sero-purulent fluid, and the surgeon, in order to find the worm, should cut the raised cuticle off. "There will then be seen protruding from a little hole in the centre of the denuded cutis one or more inches of the worm, of the size and color of vermicelli or of a wax match. The surgeon now makes a small quill-like roll of adhesive plaster, rolls the worm around it, and gently draws as much as will come without the risk of breaking; and this is repeated day after day, till at last the tail, which ends in a small hook, comes wriggling

out, and the case is at an end."[1] Under these circumstances a rapid cure takes place. Should the worm break, a subcutaneous abscess is almost sure to form higher up; and when this is opened, a loop of the worm can most likely be got out on a probe, and so be extracted as before.

At times no bleb forms, but merely a subcutaneous abscess. In exceptional cases more than one worm may exist. Druitt quotes a case in which nineteen had been extracted.

Considerable constitutional disturbance often attends these local changes.

Chigoe, Chigger, or Gigger, or Sand-Flea.—This is found in the West Indies and in South America, but the impregnated female only infects man. It makes its way beneath the nails or between the toes by means of its long proboscis, and, having gained an entrance, rapidly increases to a white globular vesicle the size of a pea. Some local irritation attends its presence. To prevent trouble, the insect should be carefully turned out of its bed by dilating the orifice through which it entered with a needle, care being observed not to rupture the globular vesicle which contains the ova; for if these escape into the cellular tissue, the accident is often followed by tedious suppuration and ulceration.

The echinococcus, or hydatid, the larva of the *Tænia echinococcus*, is a common entozoon in the human subject, and it may exist as a microscopical object or as a cyst of many inches in diameter. It has highly-elastic laminated walls lined with a granular layer, and it is usually enclosed in the parts of the body infected by it in a distinct capsule formed by exudation into and the consolidation of the surrounding tissue. It contains a clear, watery, non-albuminous fluid, in which at times float some tænia heads or scolices, the so-called echinococci, or in which are found the hooklets which surround the head.

These hydatids are met with in any part of the cellular tissue of the body—in the lungs, liver, abdominal cavity, pelvis, and even in the bones; a specimen exists at Guy's in which the spinal column was so affected. I have seen them turned out of the breast, tongue, thyroid gland, pelvis, vagina, uterus, thorax, and bladder, and have removed cysts containing them from the muscles of the neck, axilla, and thigh, and have also treated many in the liver.

At times an acephalocyst contains many secondary cysts. I removed a basinful from one occupying the pelvis, and they were of all sizes (*Path. Soc. Trans.*, vol. xvii.). Hydatid tumors are to be recognized by negative symptoms; they appear as tense, globular, elastic swellings in a part, and give rise only to such symptoms as are to be explained mechanically by their presence: when dead, they give rise to suppuration.

Treatment.—This must vary with the position, size, and growth of the hydatid tumors. When the parasite occupies some position other than one of the great cavities and can be turned out of its bed by means of a free cut into its capsule, no better treatment is required. When it occupies one of the abdominal viscera or one of the serous cavities, it should be left alone, unless from its size it interferes with important functions or threatens life, when it should be tapped; but this point will be discussed in another page.

The cysticercus cellulosæ, the cystic scolex of the common tapeworm, is found in man, and is said to be the common parasite of the "measly pig." It has a quadrangular head, short neck, and cylindrical vesicular body, the head being surrounded with characteristic hooklets. It is found more particularly in the muscles and intermuscular tissue, and may affect the viscera as the former hydatid. It is known to occur in the eye, brain, heart, etc., and can be treated, when interference is called for, by an incision into the part and removal.

Trichiniasis will be considered in the chapter devoted to the affections of the muscles.

[1] Druitt, *Med. Times and Gaz.*, Jan. 3, 1874.

SURGERY OF THE LYMPHATIC SYSTEM.

CHAPTER V.

INFLAMMATION OF THE LYMPHATICS AND THEIR GLANDS.

Lymphatics may be wounded by accident or by design and no bad result ensue. At times, however, a fistulous opening that discharges lymph may remain. The same consequence may be the result of disease. Dr. H. V. Carter of Bombay has recorded three such cases in the *Med.-Chir. Trans.*, vol. xlv., and Dr. Day another in the *Clinical Soc. Trans.*, vols. ii. and xi., which through his kindness I had an opportunity of seeing. It was reported on by a committee of the society, and they confirmed the view taken of it. It was one of hypertrophy of one lower extremity of a boy, with the occasional discharge of chyle from vesicles, which were formed on varicose lymphatics. The hypertrophy had clearly an intimate connection with the distended state of the lymphatics of the limb.

An obstructed condition of the lymphatic vessels, giving rise to lymphatic œdema is now accepted as a cause of "Elephas" or Elephantiasis Arabum (*vide* page 178).

Occasionally the lymphatics after inflammation appear as a hard cord beneath the skin. In a case I had under my care some years ago this cord remained hard and contracted for many weeks after all signs of inflammatory action had ceased. It occurred in a gentleman who was in the habit at night of going through some simple muscular exercises, and in doing this the cord in the arm snapped on the inner side of the biceps. I saw him a few minutes after the accident, and felt the two ends of the cord, which were apart for about an inch. Next morning the thin skin covering the anterior surface of the fore-arm was elevated, loose, and baggy from the effusion of fluid beneath. There were no signs of inflammation or pain beyond local tenderness at the point of rupture of the lymphatic cord. In four or five days the fluid was reabsorbed and convalescence restored; the hard cord gradually disappeared and all traces of its separation became lost. I looked upon the effused fluid as lymph that had been poured out by the divided lymph tube, and which had been taken up again. I have not seen a similar accident since.

The absorbent glands, with their ducts, are liable to inflammation ("*adenitis*" or "*angeioleucitis*"), and this action is probably the result of the absorption of some septic material. It is almost always associated with a wound, punctured or open, inflamed, suppurating, healing, or scabbing; with some point of irritation or suppuration, such as a papule or pustule; with some centre from which morbific elements may be taken up. In what is called a simple wound the inflammation of the absorbents may be acute, but in the poisoned it is violent and diffused. The inflammation always follows the course of the absorbents, leading from the centre of absorption toward the glands—that is, toward the body—and it never spreads backward. When it has reached the glands, the diseased action ceases to spread—that is, it expends its force upon the group of glands in which the absorbents naturally end and does not extend through another series of absorbents to a second group. The morbific material is arrested in the glands: at least, such is the usual course of the affection. When pyæmia follows or complicates the case, it may be open to question whether the poisonous fluid circulating in the lymphatics has not been allowed to pass into the blood through its usual channels—that is, through the inflamed glands onward; but it is at least as probable that the same septic material that poisoned the lymphatics and set up inflammation in the tubes and glands was taken directly into the blood through the venous channels, thus giving rise to blood poisoning.

Absorbent inflammation usually manifests its presence in a definite way. Pain and tenderness in some of the glands are generally early symptoms; with them, or soon

following them, will be seen a painful band of redness leading from the wound or infecting centre toward the gland. This red line may be continuous or interrupted, it may be a thin streak or a broad stripe of redness, and in some instances it may so radiate into the surrounding tissues as to simulate erysipelas. It should be noted that the red lines follow the course of the absorbents, and not of the veins. With these local symptoms there will be some febrile disturbance, and very probably the attack will have been ushered in with a rigor.

Under favorable circumstances and treatment these symptoms may subside, and the red line, with the swelling of the glands and cellular tissue around the inflamed parts, together with the constitutional symptoms, will disappear.

In less favorable examples suppuration may take place, either as a local or diffused suppuration of the affected glands and surrounding cellular tissue, as a local abscess in the course of the lymphatics, or as a series of local abscesses. In extreme cases the suppuration may partake more of a diffused character, such as that already described as taking place in phlegmonous erysipelas.

With these local changes the constitutional symptoms will assume different features: the febrile disturbance will be probably great and marked by depression: rigors may repeat themselves at regular intervals, and will generally indicate some suppurative process. When typhoid symptoms appear with rigors and sweating, the case has clearly become one of blood poisoning or septicæmia.

There are thus three different classes of cases:

The "*simple*," terminating in resolution; the "*more severe*," ending in local glandular or lymphatic suppuration; and the "*complicated*," marked by diffused inflammation and suppuration, with general blood poisoning.

In the simple form the poisonous element is probably of a diluted or but slightly irritating nature, and is generally some altered secretion of a simple wound due to external irritation. In the more complicated or severe forms the poisonous element is of a more active kind, and has been either introduced from without in the form of a distinct animal poison, such as is derived from a dissection wound or the bite of an animal, or is generated from within, as seen in puerperal cases.

Inflammation of the absorbents, erysipelas, phlegmonous or otherwise, and septicæmia are all closely connected.

The effects of inflammation of the absorbents, however, are not constant or alike in all cases. In some the glandular enlargement alone is to be recognized, with more or less extensive suppuration of the glands and their surrounding connective tissue, without any external evidence of inflammation of the lymphatics leading to the glands. In others the red line of inflamed absorbents will be visible without glandular complication or little more than a slight induration of the gland. At times there will be suppuration only along the track of the lymphatics, but none in the glands, this suppuration taking the form of local abscesses. I have seen in a case of absorbent inflammation of the fore-arm and arm four distinct abscesses in the line of inflammation, with only axillary glandular tenderness.

This absorbent inflammation is most common in the extremities, though it may occur anywhere. There seems no doubt that a large number of the cases of glandular abscesses are of this nature. Pelvic abscesses in women are known to be of this kind, because pus has been found in the absorbents of the part.

Glandular suppuration in the neck is, from its position, a dangerous affection, the connective tissue of the parts being so loose and the fascia covering them so firm that burrowing suppuration often takes place. These deep-seated suppurations should be opened early and as soon as any local evidence of pus exists, and in this way—viz., by cutting through the fascia with a lancet and thrusting a director or forceps into the deep connective tissue. I have opened an abscess at the base of the tongue in this manner from beneath the jaw with an excellent result. The swelling affected deglutition and respiration and threatened life.

Treatment.—When indications of absorbent inflammation appear, the wound or sore should be well cleansed, the scab removed, and any collection of pus let out. The affected limb should be raised, the foot, when involved, brought higher than the hip, the hand or elbow than the shoulder, and warm poppy fomentations should be applied along the whole course of the lymphatics up to the group of glands in which they terminate. Some surgeons, particularly the French, advise that the inflamed line should be pencilled with caustic and dry warmth applied, such as cotton-wool; but I prefer the practice already indicated, as it gives more comfort. The application of the extract of belladonna and glycerine to the part is also most beneficial.

As soon as suppuration appears the abscess must be opened, whether this follows directly upon the inflammation or subsequently. At the very earliest period of the inflammation, when the tongue is foul, an emetic has some influence in checking its progress. A good saline purge is also beneficial.

Sedatives should be given to allay pain, such as small doses of morphia three times a day, with a double dose at night to induce sleep. When suppuration has taken place, tonics may be administered, of which iron is the best.

In chronic cases, where induration in the track of the ducts remains, mercurial ointments and friction are sometimes valuable.

Glands, and particularly those in the neck, are very apt to inflame after fevers or the exanthemata, and to give rise to much local distress. In patients who are not extremely feeble these enlargements, as a rule, subside by themselves under careful management, though in exceptional cases they suppurate.

Local warmth applied by means of cotton-wool, tonics, and nutritious food are the best remedies; but when suppuration threatens, warm fomentations are more grateful to the patient. Abscesses should be opened early. Before opening, however, it is well to try what drawing off the pus by means of the "aspirator" may accomplish, repeating the operation as the pus re-collects. In some instances a cure may be effected by these means, and thus a scar is prevented. Should aspiration fail, an incision ought to be made.

The local application of iodine under these circumstances, although a common remedy, does not appear to be of much value.

Chronic glandular enlargement is a very common affection. It is found in the strumous and feeble child as a chronic and slightly painful enlargement of a gland or glands, more particularly those beneath the jaw and about the neck, and comes on either after exposure to cold, some slight illness or local irritation, such as bad teeth, or without any definite cause. It often subsides spontaneously on the removal of the cause or on the improvement of the general health. At times these glands suppurate and leave ugly sores, the cellular tissue around the gland becoming destroyed and the skin consequently undermined. The pus from these glandular enlargements is sometimes ill formed and curdy; and when it attends the breaking down of some old disease, it may contain a chalky deposit, the produce of some degenerated or dried-up tuberculous or other matter.

Hodgkin's Disease of the Glands, or General Lymphadenoma.—There is, however, another chronic enlargement of the glands that appears to differ in all ways from the local enlargements to which attention has just been drawn. It was first described by Dr. Hodgkin in the *Med.-Chir. Trans.*, vol. xvii., and may be called Hodgkin's disease of the glands, or, for the sake of distinction, glandular tumors. He observed it first in the mesenteric glands, though any or all may be affected. In it the glands become very much enlarged, even to the size of an egg, and apparently more numerous; they present a smooth external appearance and have a soft semi-fluctuating elastic feel. On section the surface of the gland presents a smooth, bloodless, semi-transparent, loose, succulent structure; microscopically, it is made up of glandular tissue and abundance of fibro-nucleated tissue; it is of a tough, leathery consistence and exudes a clear serous fluid. The tumors are always free, each being separable from the others.

To the surgeon the disease at times appears as a local movable glandular tumor of a slow painless growth which medicine has little or no power of influencing; it has the local clinical appearance of a benign fibro-cellular tumor, and has often been excised as such.

In other instances the tumors are multiple, three, four, or many more existing in one locality, chiefly in the neck. In exceptional instances the tumors are more numerous. I have seen cases in which, on one side of the neck, the subcutaneous tissue seemed filled with loose glandular tumors readily movable one upon the other, as if simply confined by skin, in the same way as the adenoid tumors of the breast are occasionally met with. In still rarer examples the whole glandular system seems to be affected, every group of glands not only being apparently enlarged in size, but also increased in number.

This disease is often associated with an enlarged spleen, and appears pathologically to be allied to that blood disease now known as leucocythæmia, notwithstanding that in many instances the white corpuscles are not in excess.

On one occasion I had an opportunity of watching the gradual development of this affection. It began in the cervical glands and gradually involved the whole glandular system, the patient, a boy at the age of fifteen, dying with an enormous spleen and glandular tumors in every region. His blood was made up almost entirely of white blood corpuscles, death resulting from exhaustion.

Another case I treated five years ago, a woman æt. 56, has lately returned convalescent from lymphadenoma, but affected with an acute cancer of her breast.

Treatment.—For the ordinary or strumous enlargement of the glands in children there is no drug equal to cod-liver oil, the syrup of the phosphate or of the iodide of iron or the tincture of quinine being capital additional remedies.

I have not much faith in the local application of iodine in the form of the tincture, as after the second application the skin ceases to be an absorbing surface, and the iodine becomes, therefore, a mere irritant. For some years I have been accustomed to order the solid iodine to be placed in a perforated wooden box and on a shelf in the sitting- and bed-rooms, the iodine in this way evaporating gradually and iodizing the air. In all glandular, as in thyroid, enlargements, this mode of employing the drug seems to be of considerable value.

The iodide of ammonium as an ointment is a useful application when rubbed in, the iodide by this process becoming absorbed.

Good food and fresh air are also essential points in the treatment of these cases.

In Hodgkin's glandular tumors full doses of iron, as well as of cod-liver oil, seem to be the best remedies—that is, patients who can take them appear to improve in their general health, while the disease does not progress so rapidly under their use as without it; but upon the ultimate issue no remedy seems to have any decided influence. The late Mr. Bradley advocated strongly the administration of phosphorus in doses of one-fiftieth to one-fifteenth of a grain twice a day. Indeed, I am disposed to think that where the enlarged glands can be removed they should be, for I am sure that I have seen life prolonged by such an operation, if not a cure of the disease brought about. When, however, the spleen or liver is involved, no operation is justifiable. When isolated glandular tumors exist, they may be dealt with as local tumors and removed.

In all glandular enlargements, however, the local cause of irritation should be looked for, with a view to its removal; for practically it is well to regard all glandular enlargements as due to a chronic source of irritation, in the same way as acute adenitis is known to be a result of inflammation of the lymphatics.

Disease of the glands, as connected with cancer and syphilis, is referred to in the chapters devoted to these subjects.

DISEASES OF THE THYROID GLAND.

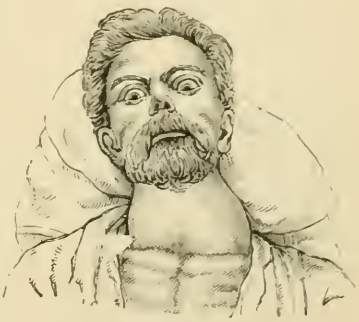
The thyroid is a lobulated, encapsuled, ductless gland with a cellular structure, the cells of which contain a glairy fluid. It is highly vascular, and has as large a vascular supply as any gland in the body; it is supposed to have some connection with blood formation. It is also freely supplied with lymphatics. The entire gland may be congenitally absent. When it is simply enlarged, it is said to be hypertrophied, or the seat of *goitre* or *bronchocele—simple adenoid enlargement*—and it is well known that these goitres attain a large size. Sometimes they are apparently composed of simple increase of tissue, the enlarged gland having much the same appearance on section as the small and healthy one; at other times the structure of the tumor is coarser, more cellular, or cystic—*cystic bronchocele*—the cysts occasionally assuming large dimensions; while in a third the gland is more solid and fibrous or more or less mixed with cysts—*fibrous bronchocele*. The thyroid gland may inflame as well as suppurate, and may be the seat of distinct adenoid tumors or of cancer. Hydatid cysts have also been enucleated from its body (*vide* Prep., Guy's Hosp. Mus., 1711[60]).

Goitre—or Derbyshire neck, as it is generally known in England—is very common. In its most usual form it appears as a simple bronchocele or hypertrophy of the thyroid gland, and gives rise to symptoms which are mainly attributable to the size of the tumor. At times, however, small tumors cause symptoms such as dyspnœa or the cough as of a broken-winded horse on exertion, and even difficulty in breathing on the slightest cause. At other times they mechanically press upon the large vessels and respiratory tract, producing headache and a feeling on stooping or coughing of fulness in the head, with evident respiratory obstruction, and even difficulty in deglutition. These symptoms may also appear for a time and then disappear, leaving the patient comfortable in all respects during the intervals. In other cases goitres which appear to be of the simple kind begin to pulsate under excitement or other unknown cause, and are attended with some protrusion of the eyeballs. These symptoms disappear with rest and time, and the case subsequently reassumes the clinical features of a simple goitre. *All these tumors rise and fall with the larynx in deglutition.*

Such cases as these stand as a kind of link between the simple and that known as the *exophthalmic* goitre, Graves's or Basedow's disease; and yet between these two affections there must be some wide difference, for the simple goitre appears to be a local affection, whereas the exophthalmic form is probably part of a more general disease marked by the enlargement of the thyroid body, often by prominence of the eyeballs, always by palpitation of the heart, a peculiar thrill in the blood vessels, and a general want of muscular and brain power (Fig. 68). "There is no known post-mortem condition of the thyroid gland proper to this disease" (Wilks and Moxon). Modern notions tend to indicate that this form of goitre is a neurosis of the cervical sympathetic. "The numerous functional disorders which occur in Graves's disease are either due to temporary congestion of the sympathetic nerve or a permanent structural alteration of the ganglionic nervous system" (Trousseau's *Clin. Med.*). This view, however, of the affection is not yet proved, and the whole subject requires investigation.

Treatment.—Simple goitres are to be treated on ordinary principles—viz., by attention to the general health, the inhalation of fresh air, and by tonic medicines. Filtered or distilled water such as the saluturis should always be taken, more particularly in districts where chalk, lime, and magnesia abound. In Derbyshire and the Tyrol districts it is generally believed that it is from the water that the disease is produced. Iodine has always been held in high repute in this affection, originally as burnt sponge and recently in the form of the iodide of potassium; and in four- or five-grain doses, given with bark or quinine, this drug is of use. For some years, however, I have given tonics alone by the mouth, and have ordered the air of the room to be kept iodized by means of solid iodine put into a box with a perforated lid, as already described; the metal thus evaporates steadily into the room where the patient sits and sleeps, and in this way it becomes absorbed. Under its influence I have often been surprised to find how rapidly goitres disappear. With this treatment I at times rub in an ointment of the iodide of ammonium, a drachm to an ounce. To paint a goitre with the tincture of iodine is useless, as one application renders the skin hard and incapable of absorption. Dr. R. Stoerk of Vienna (1874) injects alcohol into the soft parenchymatous and cystic varieties, one or two drachms being introduced by means of a Pravaz syringe, turning the goitre hard by causing coagulation of its colloid contents. The injections should be repeated at intervals of several days in different parts of the tumor. He, however, advises that a few drops of iodine should be added to the alcohol, to prevent fermentation taking place. Dr. Lücke of Berne is in the habit of treating hard goitres by injecting strong tincture of iodine into the tumor, one or more punctures being made at a time according to the size of the tumor, and, he reports, with good success (*Lancet*, 1859). Dr. Mouat of Bengal spoke (*Indian Annals of Med. Science*, 1857) very highly in favor of the use of biniodide of mercury in combination with the rays of the sun for the cure of goitre. He used the mercury as an ointment of the strength of three drachms to a pound of lard. It was rubbed in for ten minutes an hour after sunrise, and the patient had afterward to sit with his goitre held well up to the sun as long as he could endure it. After this a fresh layer of ointment was to be applied with a careful and tender hand, the patient sent home, and the ointment left to be absorbed. In ordinary cases this treatment was said to have been sufficient to effect a cure, and that only in exceptional cases was a fresh application necessary. He gives his cases of recovery by thousands. It is possible that in England the treatment has failed for want of the rays of the sun. I have tried it without the slightest beneficial result. The practice I have followed with encouraging success during the last few years has been the injection into the tumor of 20 or 30 drops of a mixture in equal parts of the tincture of iodine and alcohol. In some cases one injection brings about a cure; in others many are required.

Fig. 68.



Exophthalmic Goitre (Wilks's case).

In Graves's disease iodine appears to be not only useless, but injurious. Tonics, more particularly iron, are apparently the most applicable.

In exceptional cases a goitre may so increase and press upon the larynx and surrounding parts as to threaten life, and may even cause death by a gradual process of suffocation, but more commonly by exciting some sudden laryngeal spasm. In 1869 I treated such a case, sent to me by Mr. Holman of East Hoathly, in which a large thyroid

gland was causing chronic suffocation by its mechanical pressure, and it ultimately produced immediate death by exciting some laryngeal spasm. Dr. Herbert Davies has recorded a similar case (*Path. Soc. Trans.*, 1849), and in the museums of St. George's and Bartholomew's hospitals preparations exist with similar histories.

In some cases the treatment by setons has been of value, suppuration of the thyroid having been followed by a rapid subsidence of the hypertrophied or fibrous structure of the gland. Mr. Hey of Leeds adopted this practice with much success. In other examples of goitre the question of operative interference may have to be entertained, and will be considered in another page.

Cystic Bronchocele.—*Cysts* are often met with in this gland, and occasionally they assume large dimensions. They appear as more or less globular, tense, fluctuating tumors moving up and down with the larynx, as all thyroid tumors do. They may contain only the glairy fluid of the gland, or a more serous or sanguineous fluid or old grumous blood. Occasionally, on being punctured, they will go on bleeding, even to the death of the patient. Such cysts appear either in one or other lobe or in the isthmus. In 1872 I treated, with Dr. Hess, a case of blood cyst of the isthmus in a girl, and drew off about half an ounce of a thick, grumous, coffee-looking fluid. In 1863 I tapped a cyst the size of a cocoanut in the right lobe of the thyroid of a woman æt. 26 which bled profusely, and the hemorrhage was only arrested by closing the wound. The cyst filled up at once nearly to its former size, but subsequently gradually contracted; and after five or six years scarcely any remains of it could be found. Simply tapping a serous cyst may cure it. When it fails, the cyst should be injected with half a drachm of the mixture of iodine and alcohol, mentioned above, or, on this failing, of one of the same mixture and the liq. ferri perchloridi in equal parts. When these fail, a seton has been recommended; but the practice is dangerous and should only be adopted when simpler means are unavailing and further interference is requisite. In cysts of the isthmus, more particularly blood cysts, an incision into the cavity is a good and successful operation. Should a cyst, after tapping, suppurate, it must be dealt with as an abscess and freely opened as soon as the existence of pus can be made out; for the thyroid is in a dangerous position for suppuration to occur. I have successfully treated one case of suppurating thyroid cyst after tapping by incision, but the cases in which this treatment is called for are rare.

Dr. M. Mackenzie has (*Lancet*, May, 1872) advocated the practice of converting the cystic disease of the thyroid into a chronic abscess by the following means: "First empty the cyst. When practicable, it is well to make the puncture as near as possible to the median line and to select the most dependent portion of the tumor for the introduction of the instrument. As soon as the trocar is felt to pierce the cyst-wall it should be withdrawn, and the canula passed farther in by means of a blunt-pointed key. The fluid having been withdrawn through the canula, a solution of the perchloride of iron (two drachms of the salt to an ounce of water) is injected through the canula by means of a syringe. The plug is reinserted and the canula secured in position by a strip of plaster. The injection of iron is repeated at intervals of two or three days until suppuration is established. When this point is reached, the tube is withdrawn, poultices are applied, and the case treated as a chronic abscess. Where the tumor consists of more than one cyst, it may be necessary to make a second or a third puncture; but it frequently happens that other cysts can be opened through the cyst originally punctured." Some cysts become calcareous and should be treated by excision. The practice is only, however, to be entertained when the cyst causes symptoms which threaten life. In Guy's Hosp. Museum there is a preparation of a calcareous cyst with an intra-cystic growth.

Acute inflammation of the thyroid gland is doubtless a rare affection. I have never seen such a case. Holmes Coote records one in *Holmes's System*. Suppuration of a cyst in the gland after surgical interference is more common.

Acute hypertrophy may appear and produce dangerous, if not fatal, symptoms. Sir Risdon Bennett, in his interesting *Lumleian Lectures for 1871*, has recorded such an instance, which I had the advantage of seeing in consultation with him and Mr. Jackson of Highbury. It was in a young man æt. 19, who three months before became the subject of paroxysmal attacks of asthmatic dyspnœa, associated at times with a wheezing or whistling respiration and some general enlargement of the base of the neck. Three days before his death this difficulty became extreme, the paroxysms became more frequent and severe, and on the day of his death a severe paroxysm took place, which passed on to a forced and heaving respiration beyond anything I had ever before witnessed, and speedy

death resulted. I performed tracheotomy upon the patient with the slender hope that some light might be thrown upon the nature of the case to guide us in its treatment, if not to give relief; but in doing so what was probable before became evident then—viz., that the obstruction was below. I had no perforated instrument with me long enough to force beyond the point of obstruction except a female catheter, which struck against some solid body that prevented its progress. After death the thyroid body was found to be much enlarged, and mainly below the sternum and along the sides of the trachea. The trachea below my opening was flattened laterally to within half an inch of the bifurcation and was also twisted to the left, being surrounded by the greatly enlarged and firm lateral lobe of the thyroid. The structure of this enlarged gland was clearly that of hypertrophy, not of cystic or other apparent disease. As an example of acute rapid hypertrophy of the thyroid, the case, says Bennett, "points to the propriety of regarding any acute enlargement of this gland in young people with more anxiety than we are perhaps accustomed to do," particularly, it should be added, when the lobes of the gland pass down behind the sternum.

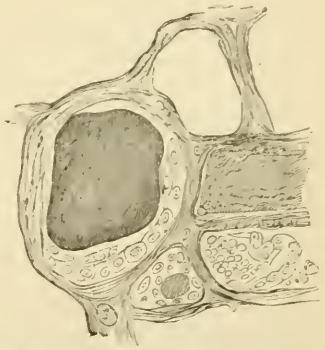
Thyroidal tumors doubtless exist, although they are not common; these may be *adenoid* and innocent or *cancerous* growths.

An adenoid growth may appear as a tumor within the gland itself or connected with it, or more commonly as an intra-cystic growth similar to that seen so frequently in the breast. In their clinical history such cases cannot well be diagnosed from the ordinary goitre, although, when the disease is unilateral and assumes a rounded or irregular form and appears to be an isolated outgrowth of the gland itself, the nature of the tumor may be suspected; when placed, however, within the gland itself or within a cyst in the gland, the diagnosis is impossible. In Fig. 69, taken from a drawing by Dr. Moxon of an old preparation in the Guy's Hospital Museum (1711[45]), a tumor the size of a grape is depicted hanging down loosely by a pedicle attached to a lobe of the gland. In the gland there is a well-marked, cuplike depression, from which the tumor had fallen out, the pedicle mainly consisting of a large artery emerging from the gland. The growth had an ossified capsule and was composed of a structure like that of thyroid tissue (Fig. 70). My late colleague, Mr. Poland, has recorded a like case in which excision was successfully performed (*Guy's Hosp. Rep.*, 1871). Frerichs, Rokitansky, and Virchow record somewhat similar instances. Paget thus refers to the subject of accessory thyroid tumors: "These growths of new gland tissue may appear not only in the substance of the enlarging thyroid, but external to and detached from the gland. Such outlying masses of thyroid gland are not rare near bronchoceles, lying by them like the little spleens one sees near the larger mass. Their history is merged in that of bronchoceles (see *Virchow*, lect. 22), with which they are usually associated, whether imbedded as distinct masses in the enlarged gland or lying close to it, but discontinuous."

Fig. 69.

Pedunculated Thyroidal Tumor.

Fig. 70.



Microscopical Appearance of Thyroid Glands. (From Dr. Moxon's drawing.)

Cancerous growths appear as infiltrating affections of the gland or as distinct tumors; they have no special clinical characters until they attack the surrounding tissues by continuity or break down. In a case of my own the disease perforated the trachea. The Guy's Hosp. Mus. contains four preparations of this disease.

Operative Interference in Thyroidal Tumors.

Many operative proceedings have been suggested and adopted for goitre and thyroidal tumors. Sir W. Blizard, Earle, and Coates (*Med.-Chir. Trans.*, vol. x.) tied the superior thyroid arteries, with the view of starving the disease, and Coates's attempt was attended with success; but the operation is necessarily a severe one, and the free arterial supply from the inferior thyroid arteries tends to neutralize its good. At the present day it is properly discarded. Setons have likewise been used with good success and deserve a

more extended trial. Injections of the tincture of iodine or of iron have been of proved value.

Removal of the isthmus is an operation which commends itself to our attention, since it is said to have been of use in the hands of continental surgeons, and Mr. Sydney Jones related at the Clinical Society on May 25, 1883, a case in which a complete cure followed the measure in a boy with a large goitre attended with dangerous symptoms. The isthmus was excised after having been ligatured on both sides, and after the operation the lateral lobes withered.

Excision is an operation worthy of consideration when life is jeopardized from the growth and less severe measures have failed or are inapplicable. That it can be done successfully has been proved by Reverdin of Geneva, P. H. Watson of Edinburgh, and Dr. W. Warren Greene of Maine.

Hemorrhage is the chief danger to be dreaded in the operation; but if the fingers be well used to enucleate the growth, without dividing or cutting into its capsule, and if the pedicle containing the vessels which supply it be rapidly reached and ligatured, bleeding may be disregarded. As an extra point of caution it appears to be a sound practice to ligature before cutting all parts that require division, in the same way as the surgeon does in ovarian cases, and for the same reason. Should the tumor turn out to be an adenoid growth in or connected with the gland, as in Poland's case, it may be removed with comparative facility; and should it be an enlarged gland simply, even a pound and a half in weight, success may follow, as was proved by Greene's and Watson's cases. Indeed, I cannot do better than give the several steps of the operation in Dr. Greene's own words:

"1st. Exposure of the tumor by linear incision of ample length, avoiding most sedulously any wounding of the tumor or its fascia propria.

"2d. Division of the fascia propria upon the director.

"3d. The reflection and the enucleation of the tumor with the fingers and handle of the scalpel, paying no attention to hemorrhage, however profuse, but going on as rapidly as possible to the base of the gland and compressing the thyroid arteries.

"4th. Transfixion of the pedicle from below upward with a blunt curved needle armed with a double ligature, and tying each half, or, when practicable, dividing the pedicle into as many portions as there are main arterial trunks and tying each portion separately.

"5th. Excision of the gland and subsequent dressing of the wound, as in ordinary cases."

Dr. P. Heron Watson, in an interesting paper on the operation (*Edin. Med. Journ.*, September, 1873), strongly advises that "the investing fascial sheath of the thyroid should be left undivided until the mediate ligature of the vessels included in their fine cellular sheath has been effected;" and he proved by cases that this can readily be effected through the wound made for the removal of the gland. He condemns anything like roughness in the removal of the gland, and believes that the operation he advocates, and had successfully performed in five cases, is easy, rapid in execution, and devoid of risk.

I cannot forbear, however, from quoting Dr. Greene's concluding remarks, which are so full of sound sense and wisdom: "I cannot refrain from one word of warning to my younger brethren, whose ambition may make their fingers tingle, lest they should in the light of these successful cases be too easily tempted to interfere with these growths. It is, and always will be, exceedingly rare that any such interference is warrantable—*never* for relief of deformity or discomfort merely, only to save life; and if it is beyond all question determined in any given case that such an operation gives the only chance for snatching a fellow-being from an untimely grave, be it remembered that accurate anatomical knowledge and a perfect self-control under the most trying ordeals through which a surgeon can pass are indispensable to its best performance."

SURGERY OF THE NERVOUS SYSTEM.

INJURIES OF THE HEAD.

CHAPTER VI.

CONTUSIONS AND WOUNDS OF THE SCALP.—BLOOD TUMORS.—OSTITIS.

Injuries of the head should always be estimated *primarily* with reference to the amount of injury the cranial contents have sustained; and *secondarily*, with reference to the risk of their becoming involved.

However trivial an injury of the head may appear to be, it is never to be lightly regarded, since what may seem a simple cutaneous bruise the result of a blow upon the head unaccompanied by any symptoms of brain disturbance may be followed by an acute inflammation of the diploë of the skull—a condition fraught with great danger—or a chronic inflammation of the bone, which is scarcely less serious; and when, as a primary effect of injury, there is evidence of brain concussion, which, as a rule, means brain bruising, the risks of secondary hemorrhage or intracranial inflammation are not slight. The latter complication follows the slighter as well as the graver injuries. It is well for the student to have these truths impressed on his mind at the beginning of a chapter on injuries of the skull, for they have a practical bearing of wide importance.

Contusions of the Scalp and Blood Tumors.

The integuments of the scalp have this peculiarity—that they are intimately connected with the aponeurosis of the occipito-frontalis muscle; indeed, practically, these parts may be regarded as one, for they are not to be separated and move together over the cranium. They are well supplied with vessels, and, consequently, have considerable power of repair; they rarely slough. When any great effusion of blood complicates a contusion, a *blood tumor* is said to exist; and when this occurs on the scalp, the affection is known by the term *cephal-hæmatoma*. In newly-born children this affection is frequently met with, and it is commonly, although not always, a result of a difficult or instrumental labor. It is usually situated over the parietal bone, showing itself as a more or less circumscribed, soft, fluctuating tumor; but the largest I have ever seen was over the occipital bone. When the tumor is small and confined to one bone, the blood is probably effused beneath the pericranium (*subpericranial form*). When the swelling is larger and spread over more than one bone, the effusion, doubtless, is poured out beneath the aponeurosis of the scalp (*subaponeurotic form*).

In the subpericranial form the indurated base may organize, or inflammatory matter may be poured out around it and assume the character of bone; whilst in neglected cases suppuration may follow, which occasionally passes on to involve the bone itself.

In the subaponeurotic form the blood is generally rapidly absorbed, and during the process a peculiar characteristic crackling sensation will be often given to the hand in manipulation. In feeble infants this process of absorption may be delayed or may fail altogether; under which circumstances, surgical aid is called for.

In the adult, in addition to the forms of blood tumor just described as a consequence of injury, blood may be effused into the skin itself, and appear as a hard unyielding lump.

When a blood tumor has an indurated base, rising from, and apparently continuous

with, the bone, with a defined edge toward the centre, the idea may present itself that a fracture with depression exists. Under such circumstances the surgeon will be assisted in his diagnosis by firmly pressing his thumb or finger for a few seconds upon the ridge: this act in a recent case, by displacing the fibrin, reveals the uninterrupted continuity of the bony surface, and thus proves the nature of the case—more particularly when there is an absence of symptoms of fracture. When the case is complicated with brain symptoms or a ruptured artery, giving rise to pulsation in the tumor, some difficulty in diagnosis may be experienced.

TREATMENT.—A *simple contusion* of the scalp, uncomplicated with any great effusion of blood or other local injury, requires little surgical attention; it has a tendency to recover like contusions of other parts. Its best application is a cold or spirit lotion, muriate of ammonia in solution being as good as any. When a blood tumor exists which feels tense or pulsates, broken ice in a bag or one of Leiter's coils (Fig. 9, p. 49) should be applied, the cold checking the further flow of blood and encouraging absorption. When the rupture of a large artery, such as the temporal or occipital, is suspected, as indicated by the pulsation of the tumor or other significant symptom, it may be advisable to apply pressure over the trunk of the vessel. When absorption of the effused blood does not take place, the cystic swelling should be aspirated and pressure applied, sponge pressure being the best; and this operation may be repeated several times. Should tapping fail, an incision ought to be made sufficient to allow of the free escape of the pent-up fluid and to prevent its re-collection; gentle pressure should subsequently be applied on the part. In very obstinate cases the tumor may be treated as a serous cyst and injected with iodine. When the effused blood breaks up and causes suppuration—a somewhat rare result—a free incision with drainage is required and the case must be treated as one of abscess. During this period tonic treatment is often required to improve the patient's powers. When the tumor is large, the patient should be kept quite free from excitement and the diet carefully regulated according to the special wants of the case. As a rule, all such cases do well.

SCALP WOUNDS.

Wounds of the scalp are very common, and large portions of the scalp may be torn away from its connections with the pericranium or bone and on readjustment live, though much bruised and injured, the extreme vascularity of the scalp favoring its repair. Such injuries, when not complicated with injury to the skull or its contents, generally do well. Blunt instruments, forcibly applied, produce scalp wounds very like those caused by sharp-cutting ones.[1] Wounds which exhibit entire hair bulbs projecting from the surface of their sections have been probably produced by a blunt instrument, while on the other hand, when the hair bulbs are found cut, the wound has to a certainty been caused by a sharp one.

It is generally thought that scalp wounds are especially "liable to prove the exciting cause of erysipelas." I doubt the accuracy of such an assertion, because from my notes of 175 cases of scalp wounds admitted consecutively into Guy's in eight years—and it must be added that only the severe are admitted—I find that erysipelas followed only in three, or in 1.71 per cent., this proportion being about the same as that obtaining in surgical cases generally.

Lacerated or contused wounds of the scalp rarely slough and should be treated as the incised. Punctured wounds are, however, liable to be followed by diffused inflammation beneath the scalp.

TREATMENT.—Under all circumstances and conditions, scalp wounds should be gently and carefully cleaned with tepid water and their edges adjusted and maintained in position; and to aid this the hair should be removed in the neighborhood of the wound. When the wound is not extensive and its edges can be adjusted by plaster, sutures are not needed; but when any difficulty is experienced, they may be as fearlessly applied to the scalp as to other parts. In extensive lacerations, indeed, the application of sutures is decidedly preferable to any other form of practice, inasmuch as with their use the wound can be kept clean and moist by dressings, which is not possible where a quantity of strapping has been employed. In the application of the suture, however, care must be taken *not* to include the aponeurosis of the occipito-frontalis muscle, for there is more danger of setting up mischief in the cellular tissue beneath this tendon when this practice is adopted than when the sutures simply pass through the skin itself. The kind of

[1] *Vide* paper *Glasgow Med. Journ.*, January, 1876, by Dr. Wm. MacEwen.

suture is unimportant, although many surgeons prefer the metallic. All sutures should be removed on the second day, as wounds of the scalp heal rapidly. The head in all these cases should be kept cool.

When the pericranium is torn off and the bone exposed, no difference in practice is needed, the prospects of a satisfactory recovery under these circumstances being as good as in a less complicated case. When the bone, however, has been much injured, superficial necrosis may follow. Should exudative or inflammatory fluid collect beneath the flaps, the sooner a free escape is given to it the better, since by its retention suppuration, which is always associated with great danger to the periosteum, to the bone, and even to the life of the patient, is encouraged. To attain this end the edges of the wound should be separated in parts by means of a probe, or *limited* incisions should be made through the tissues down to the bone. By adopting this practice early the inflammation will often be prevented or checked and the extent of mischief limited.

When diffused suppuration has taken place beneath the scalp, the pus should be evacuated by incisions well placed for drainage, the action of the occipito-frontalis muscle controlled by the pressure of a circular elastic bandage or strapping, and the surfaces of the suppurating cavity kept in apposition by sponge pressure.

To the wounds absorbent antiseptic dressings should be applied.

When extensive sloughing takes place, there is no reason why a good recovery should not follow if the powers of a patient be good and his kidneys sound.

The powers of a patient must be kept up by tonic medicines, such as iron or quinine, generous diet allowed, and stimulants employed when needed. Sedatives to procure sleep are also essential.

When bleeding is troublesome, the arteries should be twisted, acupressed, or ligatured; when it occurs merely as a general oozing of blood, pressure may be applied either to the wound or to the trunks of the supplying vessels. In rare cases, where the deep vessels of the temporal fossa are wounded and bleeding cannot be arrested, the question of applying a ligature to the external or common carotid may have to be entertained. It has never fallen to my lot, however, to witness such a case.

Contusion of the Bones of the Skull.

This is, doubtless, a common consequence of scalp injuries both with and without a wound, as is a scratching or abrasion of the bones; and yet in the majority of such cases a good recovery takes place. In exceptional cases, however, a different result is met with, in the shape of either an acute inflammation of the bone with all its dangers, or a chronic inflammation with all its difficulties.

Acute inflammation of the bone is a severe affection, more particularly when the diploë is involved; for the diseased action may extend inward and give rise to a local suppuration between the bone and the dura mater or between the layers of the arachnoid, running on to a diffused inflammation of this membrane and of the brain itself.

A chronic inflammation of the bone may be followed by very similar results or by a thickening of the injured bone.

When necrosis of the skull is present, these results are always liable to occur, and with it a low kind of phlebitis of the cerebral sinuses and pyæmia are prone to follow.

Symptoms.—The symptoms which indicate either of these two conditions appear at variable periods after the accident and vary in intensity according to the action. In *acute* cases the symptoms may show themselves within a few days with severe constitutional irritation and headache, passing on to general brain disturbance, convulsions, paralysis, coma, and death. In *chronic* disease the symptoms may not appear for weeks or months, and they will be less severe; but persistent headache is always present. When the inflammation spreads inward toward the arachnoid and brain, other symptoms show themselves, such as severe local pains, delirium, twitching of the muscles, convulsions, paralysis, coma, and death, the rapidity of the progress of the disease governing the symptoms. When marked rigors appear, suppuration is indicated, often of the pyæmic kind; and convulsions of an epileptic nature are frequently found in the chronic form of the disease. *Persistent headache* after an injury to the head is always a symptom demanding anxious attention, as it too often means progressive mischief within the skull. This subject will, however, receive further elucidation in the chapter on "Intracranial Inflammation."

INJURIES OF THE CRANIUM.

There are some leading practical facts or principles which should be impressed upon the memory of every surgeon who has to deal with injuries to the head. These I have formulated as follows, believing it to be well to place them at the beginning of a chapter on such injuries.

1. A concussed should be regarded clinically as a bruised brain.

2. Fractures or injuries of the skull are of importance so far as they are associated with damage to the skull contents, a compound fracture uncomplicated with shaking of or injury to the cranial contents being less liable to be followed by bad results than a simple fracture associated with brain mischief.

3. The amount of injury to the brain cannot be estimated by the severity of the primary symptoms, a severe injury to the brain being frequently associated at first with mild, and a slight injury with severe, symptoms.

4. A general shaking (concussion) of the brain, whether associated or not with simple or compound fracture, may give rise either to temporary suspension of brain functions, ending in recovery, to laceration of the membranes, to a more or less severe bruising of the cortical structure of the brain, or to laceration of its deeper substance. The amount of hemorrhage which complicates the case depends upon the size, number, and healthiness of the ruptured vessels. Thus a general shaking or concussion in a healthy brain may only produce a temporary suspension of cerebral functions, when the same injury in an unhealthy or aged one in which diseased vessels ramify may be followed by a fatal hemorrhage or apoplexy.

5. Under certain conditions of the system, and particularly where the kidneys are diseased, a slight concussion will be followed by a fatal secondary inflammation of the brain-coverings; while under other conditions a severe injury to the brain will be followed by no such result.

6. Intracranial inflammation is as prone to follow the milder as the graver cerebral injuries.

7. The character of the accident and the mode of its production furnish the best means for estimating the nature and severity of the injury and its probable results, since a fall upon the head from a height or a blow from a heavy weight causes a *general* injury of the brain, and a fall upon or a blow from a sharp instrument a *local* one.

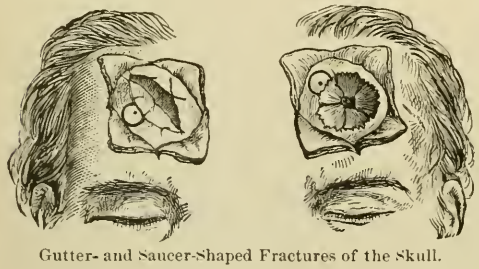
With these general propositions, which the student should learn and think over as a guide, I now proceed to consider the subject of fractures of the skull.

FRACTURES OF THE SKULL.

These may be divided into fractures of the "*vault*" and fractures of the "*base*," a third and large division including those of the "*vault and base*." They may likewise be "*simple*" or "*compound*," "*comminuted*," "*depressed*," or "*undepressed*."

Fractures of the vault are generally caused by direct blows upon the part or falls upon sharp bodies. They include most of the *punctured* fractures and *incised* wounds of the bone, as in sword wounds, etc. They are of necessity compound, and often comminuted; and the brain injury which is associated with them is for the most part local.

Fig. 71. Fig. 72.



Gutter- and Saucer-Shaped Fractures of the Skull.

When not punctured, the fracture may appear as a simple fissure, the extent of which is determined by the amount and character of the force employed, the line of fracture being influenced by the sutures and ridges of bone. When the force is local and moderate, the fracture may be limited; when concentrated and severe, the fracture will be "starred," and generally "comminuted," the fissures radiating in all directions, involving many bones, and passing downward toward the base. When inflicted with a blunt-edged instrument, the fracture will be depressed in a gutter shape (Fig. 71); when with a round one, as a hammer, the bone will be depressed more like a "saucer" (Fig. 72).

Comminuted fractures are generally the result of a concentrated local violence, and are consequently found chiefly in the vault and are mostly compound (Fig. 73).

In some cases of fracture of the vault the bone will be depressed or driven in upon the cranial contents; in sabre wounds it may be elevated, ploughed up, or displaced outward.

The fracture will be confined in some cases to the outer table of the skull, in rarer instances to the inner, a fracture with depression of the inner table occasionally existing without any fracture of the outer.

When the force acts from *without* and is *great*, the whole thickness of bone may be broken, the inner table probably giving way first and being fractured to a greater extent than the outer; but when the force is *slight*, the inner table may be alone fissured, loosened, or driven in.

When the force acts from *within*, upon the inner table first, the reverse of the above holds good, the outer table giving way before the inner and being fractured to a greater extent. In Prep. 1082[70], in Guy's Museum, this not sufficiently recognized fact is well demonstrated. In it, the force having been applied by a pistol bullet which was sent by a suicide through his brain, the point of impact on the inner table is represented by a black mark, whilst the outer table is starred; and in Prep. 1083[75], taken from a boy æt. 12, fracture of the outer and inner tables exists, but not in corresponding parts.

An interesting paper on this subject will be found in the *American Journ. of Med. Science*, April, 1882, by Mr. J. Lidell.

Fig. 73.

Comminuted Fracture of Skull with Depression of Inner Table from Direct Local Violence (Prep. Guy's Mus.).

As points of practice, however, it is well to remember that in all ordinary cases of fracture, with depression of the bones of the skull, the injury to the inner table is far greater than to the outer, and the point of exit of any foreign body through the skull is always larger than that of entrance.

Whether depression of the bones of the skull of an adult ever occurs without a fracture is an open question. There is certainly no good evidence in support of the fact. In children it has happened without giving rise to any symptoms of brain compression; yet even here, says P. Hewett, "some of the bony fibres must have given way." In these cases the depressed bone may subsequently rise up again to its natural level.

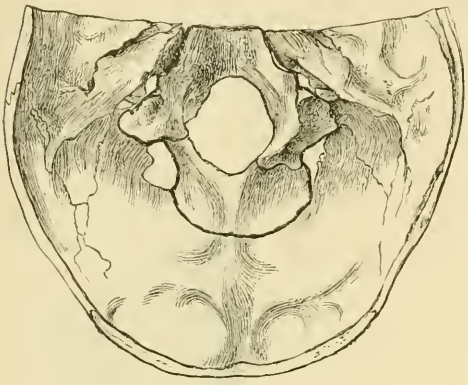
Brain Complications.—The practical interest, however, attached to all these varieties of fracture is concentrated in the question as to how far the cranial contents are involved in the injury. Has the brain been slightly concussed, or so shaken as to have been bruised or lacerated? Have the membranes of the brain been torn, lacerated, or injured? Is the fractured bone a source of irritation to the dura mater? Is there a loose fragment of the inner table of bone acting as an irritant? A compound fracture with or without depression, not complicated with brain disturbance or brain injury, is a cause of far less anxiety than a simple fracture in which severe brain concussion has taken place and is indicated by symptoms; a severe shaking of the brain, whether complicated or not with a fracture, is a far more serious accident than any local injury to the skull alone.

Fractures of the base of the skull or vault and base combined—for these conditions ought to be considered together—are invariably severe injuries. They are generally, except when produced by a crushing of the head, caused by a diffused force, such as that occasioned by a fall from a height upon the vertex or by a heavy blow. "When the former, the plunge of the body is suddenly arrested by the vertex coming in contact with the ground, and the entire superincumbent weight, with the superadded momentum acquired by the velocity of the fall, is concentrated around the condyles of the occipital bone, and the central compartment of the base of the skull is thus broken across" (Fig. 74). The fracture is the result of direct violence, and not of so-called contre-coup.

"Thus, if the injury be inflicted by the fall of a *hard* and heavy body on the vertex, this part would be fractured; and if the weight were not very great, the mischief might end there, as the resistance offered by the head may so far exhaust the momentum of the falling body that the force would not be transmitted in sufficient amount to cause fracture of the base. But if the weight and momentum of the falling body were in

excess of the expenditure of force in causing fracture of the vertex, the impulse would drive the head down upon the summit of the spinal column, and fracture of the base would result; in that case, viewed mechanically, the lower fracture would be successive to the upper. But if the falling weight which struck the vertex were of a yielding material, fracture, if any, would be in the base, and not of the vertex, because the *vis inertiæ* of the skull would be overcome, and it would be driven down upon the spine without the application of circumscribed force to the vault. The same reasoning applies when fracture of either the vault or base, or of both together, is the effect of a fall on the vertex; or this result may be varied by the blow being received on the forehead or occiput, the anterior or posterior divisions being thin and severally more obnoxious to fracture."

Fig. 74.



Fracture of Base of Skull from Fall on Vertex.

Injuries to the occiput are commonly followed by longitudinal fracture of the base, involving both the posterior and middle fossæ.

Injuries to the temporal region or about the ear are followed by fracture of the petrous bone and the middle fossa; they are always serious.

But it is rare in diffused injuries to the head to find one fossa alone involved: fissures generally pass through two fossæ and extend from the vault or part struck.

The evidence afforded by my notes of two hundred cases of fatal head injuries clearly establish these points, which have also been experimentally proved by Dr. Aran.

"In precipitating a large number of bodies from various heights on to the head, Dr. Aran found that the part of the vault which first struck the ground gave, as it were, the key to the fracture which would take place at the base. Similar results were also obtained when diffused blows were dealt upon different parts of the skull by means of a large and heavy hammer. In the front part of the vault injuries thus produced led to a fracture of the anterior fossa, in the middle part of the vault they led to a fracture of the middle fossa, and at the back of the head to a fracture of the posterior fossa. In no single instance was a fracture detected at the base without a line of fracture in the corresponding part of the vault. The truth of this has been proved by an analysis which I made of all the cases of fractured base of the skull admitted into St. George's Hospital during a period of ten years" (Prescott Hewett).

My own observations go entirely to prove the correctness of these views. The middle fossa is the one, however, most frequently involved.

Compound fractures of the skull are, as a rule, local fractures. They are generally the result of a concentrated blow upon, or a puncture of, the part, the force employed having been expended in producing the local injury. They are, consequently, often starred or comminuted and depressed fractures. When the brain is involved in the injury, it is chiefly beneath the seat of fracture; it is rarely shaken or concussed as much as it is in simple fractures the result of a diffused blow.

The dangers attending a compound fracture do not, therefore, arise so much from the direct injury to the brain as from secondary intracranial inflammation the direct result of irritation of the dura mater by the depressed or comminuted bone, the dura mater being frequently punctured or torn and in all cases irritated by the depressed bone. These facts have an important bearing on practice, since they encourage the surgeon to remove the depressed and irritating portions of bone, which have such an injurious influence on the progress of the case. When the brain is injured by the accident, the danger is far greater.

THE DIAGNOSIS OF FRACTURE OF THE SKULL.

There are no special symptoms by which a fissure of the vault uncomplicated with a wound can be recognized. The best guide to the diagnosis of a fracture of the skull is the nature of the injury. Extensive fractures of this kind are constantly found upon the post-mortem table where no suspicion of their presence was entertained during life.

When a wound complicates the case, a fracture can usually be made out, as the fissure can be seen as a red line. Care, however, should be taken in these cases not to mistake a suture for a fracture.

When depressed bone exists with fracture, the diagnosis is rarely difficult, unless it should so happen that the fracture has taken place beneath the body of the temporal muscle, when it is almost impossible to diagnose its existence by direct signs.

An effusion of blood beneath the pericranium may be mistaken for a fracture with depressed bone, unless care be observed, as may a natural depression in the skull, particularly in the occipital region.

Fracture of the skull the result of a *punctured* wound can, as a rule, be readily recognized, though when the point of the perforating instrument has been broken short off at the surface of the bone much care is needed.

The diagnosis of a fracture of the base, or of the base and vault combined, is always a source of difficulty, since there are no signs, but only symptoms, to assist opinion. The nature of the accident is without doubt the surgeon's best guide; a fall from a height or a heavy blow upon the head is the usual cause of such an accident, though a crushing force applied in any direction may produce the same result.

Should the fall have been upon or the force applied to the vertex, the middle fossa of the skull will probably be the seat of injury; and the diagnosis of a fracture through the petrous bone may with some confidence be made when such an injury is followed by profuse or persistent hemorrhage from the ear, succeeded by the copious discharge of a watery, and perhaps saccharine or slightly albuminous, fluid, and paralysis of the parts supplied by the facial nerve. Slight hemorrhage from the ear is no positive sign; the moderate discharge also of a watery fluid alone is not characteristic, nor is facial paralysis. But profuse and prolonged bleeding from the ear, or slight hemorrhage, followed by a watery discharge, is, however, strongly indicative of a fracture, as is also a copious watery discharge directly following the injury. Facial paralysis, however, combined with either of these symptoms, renders the diagnosis complete. This watery discharge is now generally admitted to be an escape of cerebro-spinal fluid through a fracture of the petrous bone, passing across the internal auditory canal, and attended with rupture of the membrana tympani. I have known this to continue for eight days.

In injuries to the mastoid process, if a local emphysema exists, the presence of a fracture may be diagnosed.

Fracture of the Anterior Fossa.—Should the blow or fall have been upon the anterior part of the skull, the probabilities of the case point to fracture of the anterior fossa; and where any injury to any of the nerves of the orbit can be made out, as indicated by local paralysis of some of the muscles of the eye, or when hemorrhage has taken place beneath the conjunctiva, the diagnosis is certain. Hemorrhage into the eyelids by itself is of no value as a diagnostic sign, although when it follows the accident at a later period and is consecutive to subconjunctival hemorrhage it is a symptom of some importance.

Falls upon the occiput commonly produce longitudinal fissures of the base.

Copious and obstinate bleeding from the nose or pharynx is by no means unfrequent in a case of fractured base, and when accompanied with other suspicious symptoms is of diagnostic value. I have the notes of a case of injury to the head in which the patient apparently died from bleeding from the nose and mouth, no blood coming from the ear; and after death a fracture of the base was found completely separating the petrous portion of the temporal bone from its connections and laying open the lateral sinus. The right tympanum was full of blood, but the membrana tympani was entire. The stomach was full of blood, the blood from the lateral sinus having apparently found its way through the Eustachian tube into the pharynx and stomach.

I have also the particulars of a second case, in which the carotid artery was divided in its passage through the petrous bone and the lateral sinus laid open, the lungs and bronchial tubes being found filled with blood, even down to the air cells. Each of these patients lived only two hours after the accident.

Fracture of the base unassociated with any injury to the brain itself is of no more consequence than fracture of another part; but as the base is the most delicate part of the brain, and any injury to it is sure to be followed by severe, if not fatal, symptoms, the subject of fracture of the bones upon which it rests becomes of proportionally greater interest.

This fracture of the base may be associated with all the intracephalic injuries to which fractures of the vault are liable. It may be complicated with simple concussion

of the brain, or with the more severe form associated with laceration of the brain structure, or extravasation of blood upon or within the brain itself. If blood is effused, there may be compression of the brain followed by death, or the same result may be produced by a secondary inflammation of the membranes and injured parts.

It is difficult, upon the whole, to separate the two classes of cases, inasmuch as the dangers arising from injuries to the skull do not depend upon the seat of fracture, but upon the injuries to the cranial contents; and, as the same injuries may be produced by, or rather may be associated with, fractures of the base, the complications and dangers are the same in each.

Having, then, so far shown that the dangers of all forms of fracture of the skull are really alike, and that the same intracephalic complications attend fractures, whether of the vault or of the base, I now proceed to illustrate the special symptoms generally regarded as being diagnostic of such injuries by a brief analysis of cases from my note-book.

Among thirty examples which are there recorded, twelve were associated with simple concussion, in all of which recovery took place. In three cases the fractures extended through the orbit, as indicated by subconjunctival ecchymosis. In eight there was hemorrhage from the ears; in all, this was followed by a discharge of serum, and in seven of the cases it was associated with paralysis of the facial nerve upon the same side. In these it is quite fair to conclude that the line of fracture extended through the petrous portion of the temporal bone. In two there was bleeding from the nose; in one there was a serous discharge from the ear, accompanied by paralysis of the facial; in another this discharge followed hemorrhage from the ear and was unaccompanied by paralysis.

To test the value of these different symptoms as indicating fracture of the base in various positions, the following analysis of the fatal cases will prove of value; and, taking the symptoms separately, subconjunctival hemorrhage will first claim our attention, as being one which more or less accurately marks a fracture through the orbital plate. In the eighteen fatal examples, this symptom was manifested in four instances, the line of fracture extending in each of these through the orbit.

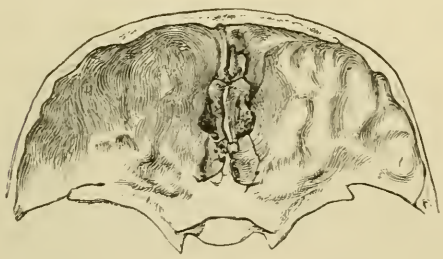
In two cases there was copious hemorrhage from the ear, while in both the fracture passed through the petrous bone.

In three examples there was some epistaxis. In one of these the fracture extended across the ethmoid bone, in another the frontal sinuses were full of blood and fractured, and in the third the tympanum was found full of blood, the membrana tympani perfect, and upon careful examination the lateral sinus of the brain was found to have been lacerated.

Seven of the eighteen fatal cases died from direct injury to the brain, the post-mortem examination in all revealing severe contusion or laceration of the brain structure, with effusion of blood upon the surface of the brain or upon the membranes.

Seven other cases died from arachnitis as a result of the injury. In four of these there was contusion of the brain, and in one ecchymosis of the ventricles; in two there

FIG. 75.



Fracture of Anterior Fossa of the Base of Skull.
(Prep. No. 1085[87], Guy's Hosp. Mus.)

FIG. 76.

a, Punctured Wound through Frontal Bone.
b, Portion of Wood which perforated Bone.
(Prep. No. 1086[60], Guy's Hosp. Mus.)

was no evidence of contused brain, nor was there any effusion of blood; in one interesting case the inflammation spread from the internal ear. In three the cerebral mischief was complicated with some thoracic or abdominal injury which caused death, and in one hemorrhage was the immediate cause of death.

A severe blow upon the nose, by driving in the ethmoid bone, may cause fracture of the anterior fossa of the base of the skull (*vide* Fig. 75), and I have had under my care several cases in which a severe blow upon the jaw produced a fracture of the middle fossa. At St. George's Hospital there is a specimen in which a fracture of the base was caused by the condyle of the lower jaw being driven against the glenoid fossa with such force that the condyle projected into the cavity of the skull, and in Guy's Hospital Museum there is a similar specimen, which was sent in with Mr. Hutchinson's prize essay. Punctured wounds of the orbit are by no means infrequent causes of fracture of the base; many are recorded. I was once called to a case in which a lead-pencil had perforated the bone and the brain through the orbital plate, and Fig. 76 was taken from a preparation in which the frontal bone was perforated. The diagnosis of these cases is not difficult. When brain matter escapes externally through the wound, there is no room for doubt.

The treatment of fractures of the skull will be described after the subjects of injuries to the brain and extravasation of blood within the cranial cavity have been considered.

CONCUSSION OF THE BRAIN, AND ITS EFFECTS.

"A man receives a blow on the head by which he is only stunned for a longer or a shorter period. What is said to have happened? Concussion of the brain.

"A man dies instantaneously or lingers some time perfectly unconscious after an injury of the head; there are no marks of external violence. Again, what is said to have happened? Concussion of the brain.

"The head is opened, and what is found? In one case no deviation from the healthy structure; in another, simply great congestion of the cerebral vessels; in another, numerous points of extravasated blood scattered through the brain substance; in another, a bruised appearance in some parts of this organ. In all, the case, in common parlance, is said to have been one of concussion of the brain. Such are the after-death appearances ascribed by different surgeons to concussion of the brain."

These words of an eminent surgeon (P. Hewett) so accurately describe the ordinary teaching of the schools that I have transcribed them as a fitting introduction to the subject of which I am about to treat. They are likewise practically true, although experience of the post-mortem room shows that in cases of death from concussion of the brain, with the rarest exception, some changes in structure are to be found if carefully looked for, some bruising or laceration of the brain, some bleeding into its substance. In fact, death from concussion of the brain without change of structure hardly ever takes place, *concussion and contusion of the brain being, as a rule, associated in fatal cases.* At Guy's Hospital, for twenty consecutive years, no case is recorded of death from concussion without change of brain structure, and it is only quite recently that an example has occurred.

"In every case," remarks P. Hewett, "in which I have seen death occur shortly after, and in consequence of, an injury to the head, I have invariably found ample evidence of the damage done to the cranial contents."

Concussion and Contusion of Brain Identical.—Mr. Le Gros Clark states: "I have never made nor witnessed a post-mortem after speedy death from a blow on the head where there was not palpable physical lesion of the brain;" and Dr. Neudorfer of the Austrian army declares that he has never seen concussion, properly so called, except in apparently trivial injuries.

M. Fano, a recent French writer, has also come to the conclusion "that the symptoms generally attributed to concussion are due, not to the concussion itself, but to contusion of the brain or to extravasation of blood." In fact, all authorities now agree that when death follows a severe shaking or concussion of the brain, contusion or bruising of the brain is almost invariably found.

How far these views are correct in cases of concussion that are not fatal is an open question, but in the few cases of concussion recorded in which death has followed from other causes some injury to the brain substance has always been found, and in all instances in which a fatal result has taken place from secondary inflammation evidence of some bruising of the brain has been detected. A bruising of the brain, however, with a slight extravasation of blood, may be recovered from; but when there is extensive effusion, compression of the brain and death are the usual result.

When it is generally accepted as true that concussion and contusion of the brain are practically synonymous, the principles of the treatment of such injuries will be better appreciated.

In the *simplest* form of concussion of a healthy brain a slight and transient loss of power and consciousness is the only symptom.

In the *more severe* form, when a blow or injury produces some severe shaking of the cranial contents, this shaking is followed by a loss of consciousness more or less complete and a loss of all power of motion; the skin of the patient will be cold, the features more or less contracted, the pulse slow and intermittent, and the pupils very variable: in some cases they will be dilated, in others contracted, while in a third one pupil will be dilated and the other contracted. If the case be neither one of great severity nor complicated with any grave injury to the cranial contents, after a variable period the patient will show signs of movement, and may, perhaps, move a limb in an impatient and purposeless manner. If he is spoken to in a loud voice, he will perhaps show some signs of returning consciousness, either by making some inarticulate noise or by merely opening his eyes, and afterward returning to his stolid condition. If the case be still carefully observed, the mode of respiration may be seen to be altered, and from being slow and labored it will be irregular, and perhaps sighing. After a time, if recovery is to take place, other signs of what are termed *reaction* will make their appearance. The skin will become warmer and more natural, the shrunken and contracted features will return to their normal condition, the pulse be more regular and rapid, and vomiting may occur. The appearance of this symptom is generally of moment and the first result of a more active circulation through the cerebral centres. As the case proceeds, if all goes well the patient rapidly recovers and returns to his natural condition, feeling, perhaps, somewhat heavy and dull for a few days, and indisposed for any bodily, and much less for mental, labor. But if, on the other hand, the case goes wrong, the symptoms may either persist or pass into those of compression, as indicated by complete insensibility, coma, and death, or the symptoms of reaction may become excessive and run into those of inflammation of the brain or its membranes.

In this brief sketch of an ordinary example of concussion of the brain the symptoms described are of a typical kind, and have been purposely dissociated from those of such complications as are liable to occur either primarily or after the period of reaction has taken place.

Effects of Concussion on the Brain.—What change of structure is present in such an injury is, of course, an open question. In the simplest case the local injury must be slight; in the more severe there is every probability that some bruising of the brain has been produced; while in the worst laceration of the brain and extravasation of blood will probably have taken place.

In what is called concussion of the brain epistaxis is very frequent and hemorrhage into the lids of both eyes is not uncommon, though beneath the conjunctiva it is very rarely met with. Hemorrhage from the ear directly after the accident is occasionally seen, and I have known it continue for several hours; the extravasation of blood takes place in all these cases as a direct result of the accident.

Again, in certain cases, a patient, having regained his consciousness, relapses into insensibility—*relapsing unconsciousness*—from which he may recover as perfectly as if no relapse had taken place. It would appear as if this condition were produced by the earliest effects of reaction, the vessels yielding too freely to the heart's pulsations and thus producing a plethora of the part, which induces a comatose or semi-comatose condition. The following case illustrates these points.

A boy æt. 11, having received a blow upon the head from a falling piece of timber, became perfectly unconscious and quiescent. He remained in this state for fifteen minutes, but, recovering, he walked home, some short distance. He soon began to feel sick and vomited, the vomiting being attended with *epistaxis*. He was then brought to Guy's with a cold skin and laboring pulse. He was very slightly conscious and unable to answer any questions, while his limbs remained in the position in which they were placed. The pupils were dilated, but active. He was left in bed with the head raised and a cold lotion applied to it. Warmth was applied to the feet. He gradually recovered, and left the hospital in ten days convalescent.

The epistaxis and relapsing unconsciousness in this case, coming together at the time of reaction, point clearly to the cause.

Again, in children, reaction is not unfrequently attended with convulsions, which generally, however, pass away and leave no mark behind. Convulsions, when they appear in an adult, are symptoms of grave anxiety, since they almost always indicate brain injury and forbode mischief.

When reaction is excessive, it is attended with symptoms of fever and brain disturb-

ance, such as delirium, excitement, and coma. The subject of intracranial inflammation will claim attention in another page.

Extravasation of Blood as Result of Concussion.

If the brain be violently shaken, bruising of its substance and more or less extravasation of blood must ensue.

When the injury is the result of a direct blow, the bruising may be but local; yet it is more usual to find the opposite side of the brain also bruised, by what is rightly termed "contre-coup," and, indeed, it very often happens that the mischief to the brain by *contre-coup* is greater than that at the seat of blow. When the fall or blow has been upon the vertex, the base is bruised; when on the occiput, the anterior lobe; when on the right parietal region, the base of the left middle lobe; in fact, the base of the brain is almost always the seat of injury.

The amount of extravasated blood will depend upon the degree of force applied; but when the vessels are diseased, the hemorrhage may be excessive. When the extravasation of blood is upon the surface of the brain, it will be either within the cavity of the arachnoid or the meshes of the pia mater; and under both circumstances the blood will gravitate to the base. When the extravasation of blood takes place into the structure of the brain, it may be found in any part of the cerebrum, cerebellum, or pons Varolii, or even in the ventricles, the extravasation rarely showing itself in the form of one large clot, but commonly in small and numerous spots of extravasation.

Results of Post-Mortem.—On referring to my notes on this subject, I find, in a case of concussion which proved fatal sixty hours after the injury, that the brain was bruised all over and blood effused at the injured spots; the fluid in the ventricles was blood-stained, and the ventricles themselves ecchymosed. In another case of death from concussion, the result of a fall, in a man æt. 31, in whom convulsions and coma supervened on the fifteenth day after the injury, a layer of blood was found universally diffused over both hemispheres, dipping between the convolutions and passing downward toward the base. The clot, which was shreddy, of a dull, reddish-black color, had evidently been effused for some days. The surface of the brain beneath the seat of injury was softened, and at the base, where it had been injured by *contre-coup*, similar changes had taken place. The vessels were healthy. In a third case, where death followed from concussion and the vessels were diseased, multiple extravasations were detected after death throughout the substance of the brain.

In all these typical cases, illustrating the different effects of "concussion," fatal results took place from changes brought about by severe shaking of the brain unassociated with fracture; but it is to be remembered that where a fracture is present, unless it be attended with depressed bone, the shaking of the brain, and not the fracture, is the main source of danger.

From what has been thus stated the conclusion may be drawn that the nature of the accident is the best guide to the diagnosis of contusion of the brain, and the severity of the symptoms or their persistency is doubtless a valuable indication as to its extent. "Tonic spasms of the limbs; intense restlessness, with constant rolling and tossing about in bed; unconsciousness, more or less complete; drowsiness, without any stertorous breathing, and in the slighter cases simply contraction of one pupil or of one eyelid; spasmodic movements about some one muscle or another of the face or lips, giving rise to a difficulty of pronunciation."—are by the French surgeons looked upon as diagnostic of a contused brain; and Mr. Le Gros Clark lays stress upon the following: "More or less constant restlessness, accompanied by spasm, in which some particular member is affected or amounting to general convulsion. If capable of giving expression to his feelings, the patient will point to some particular part of the head as the seat of pain. In some instances noisy incoherency and obtuseness of intellect accompany this condition from the first;" and these symptoms are doubtless enough to point to brain injury. When they appear rapidly after the accident, they may be accepted as suggestive of a bruising of the organ; but when they come on a few days later, they are as likely to be due to secondary inflammation of the brain as to contusion.

The diagnosis of primary concussion and contusion of the brain is unnecessary. The symptoms are so intermixed that the real nature of the lesion is not apparent. The signs attributed to concussion, such as loss of consciousness, collapse, small, scarcely perceptible pulse, and lowered temperature, merely indicate that the functions of the brain and their influence on the system at large are in a state of abeyance: and it can only be declared

that the brain was contused in the first instance *if the symptoms continue* or become aggravated.

Seat of Injury indicated by Paralysis.—The seat of injury to the brain may likewise often be indicated by some paralysis, partial or complete, of one or more of the cerebral nerves. This paralysis may be either a passing or a permanent symptom. Paralysis of the seventh pair, including the facial nerve, has been already alluded to as a somewhat typical symptom of fracture through the petrous portion of the temporal bone. This may appear as an immediate result of the injury, indicating laceration of the brain by the fracture, or, what is more usual, at a later date, when it may be the effect of pressure by effused blood upon the nerve trunk in some part of its course, or, at still later period, by inflammatory effusion.

On referring to my own notes of cases admitted into Guy's Hospital at different periods during the last twenty years, I find examples of injury to the optic nerves, as indicated by blindness, paralysis of the muscles of the globe of the eye as a whole, and paralysis of the external rectus muscle alone. Paralysis of the facial and auditory nerves is very frequent, and at times there is paralysis of the fifth nerve, as indicated by complete loss of sensation of the face, etc. Paralysis of the hypoglossal has also been observed. In the majority of these cases the symptoms appeared as a direct result of the injury; in some they came on two or three days later, associated with febrile symptoms, but in most they disappeared in the course of a few weeks. In some instances, however, of facial paralysis the symptoms were permanent. In all these there must have been injury to the base of the brain. "The coexistence of hemiplegia on one side with paralysis of the third nerve of the opposite side is indicative of lesion of the crus cerebri on the side on which the third nerve is paralyzed" (Le Gros Clark).

I had once under my care a man who received a severe blow on the left side of the head, above the ear. The injury was followed by symptoms of concussion, which soon passed away; but he had complete aphasia. In the course of a few days he partially recovered the ability to speak, but then spoke so thickly that he was unintelligible; in about three weeks he could be understood, but he did not recover his natural powers of speech for at least three months. During the greater part of this time he was subject to headache, which the least exercise or excess in diet made worse. There can be little doubt that in this case the base of the middle lobe of the right side had been contused. Mr. Callender[1] tells us "that symptoms of aphasia are more apt to follow injury of a part of the left hemisphere outside the corpus striatum than any other part, that injuries to the right hemisphere are more rapidly fatal than are equal injuries to the left, and that the right-side brain lesions are more often associated with convulsions than are similar hurts at the opposite side." The evidence of these opinions is not strong.

Remote Effects of Head Injuries.

There are, however, many injuries to the head which, without producing such definite symptoms as have been described as the result of concussion, etc., yet cause serious and often permanent damage to the patient.

The effects of a blow on the head are by no means to be determined by the immediate symptoms that result, for a person may receive a trifling or severe injury, from which he is supposed to have completely recovered, and yet the case may end in a permanent enfeeblement of the mental powers or be followed by paroxysms of uncontrollable excitement. It behoves the surgeon, therefore, to be most cautious in giving an opinion as to the issue of a case of injury to the head.

Insanity.—The records of lunatic asylums and convict prisons prove unhappily, that many cases of apparently trivial injury to the head, unaccompanied by symptoms which would indicate any positive affection, such as concussion, paralysis, etc., have ended in an affection of the brain which has rendered the patient hopelessly demented or a criminal, and, moreover, has left no visible traces of the malady in the brain after death. The following may suffice as illustrations:

A boy æt. 16 fell from a tree and was found partly insensible. After a few days' treatment he was dismissed from the hospital as "cured." In a few months he was obliged to be placed in a lunatic asylum, where he remained several years.

A gentleman put his head out of the window of a carriage while travelling by railway, and received a scalp wound from striking against a post. He was rendered insensi-

[1] *Brit. Med. Jour.*, June 6, 1874.

ble at the time, but soon improved. There were no signs of importance, yet in a few weeks he was in a state of mental aberration, and died in a year.

A man was kicked by a horse in the stomach and fell, striking his head on the stable floor, but had no cerebral symptoms. In a few weeks he got delirious and confused in mind, and became in time hopelessly insane.

Such instances might be multiplied endlessly, all pointing to the supreme importance of injuries to the head, however slight the immediate symptoms. The reader may find this subject well discussed and illustrated by Dr. J. C. Browne in the first volume of the *West Riding Asylum Reports*, in Abercrombie's works, Dr. Azane, *Archives Générales de Médecine*, February, 1881, and elsewhere.

It may be laid down as a principle that persons with any hereditary predisposition to insanity or nervous disease are more liable to suffer from cranial injuries than others. The temperate have a better chance of escape than those addicted to excesses of any sort.

INJURIES OF THE BRAIN AND ITS MEMBRANES COMPLICATING FRACTURE.

When the student has recognized the fact that a blow upon the head *not* complicated with fracture is capable of producing, by "concussion of the brain," injuries such as have been sketched in the previous pages, he will be quite ready to understand that a blow upon the head *complicated* with fracture is likely to be followed by results that are at least equally severe, since the force required to produce a fracture of the skull is, as a rule, either more violent or more concentrated than that required to produce what has been described as a concussion of the brain. There are, moreover, complications which are frequently associated with or peculiar to fracture, such as depression of bone with or without compression of the brain; extravasation of blood external to the dura mater from rupture of a blood vessel, such as the middle meningeal artery or venous sinus; injury to the dura mater or membranes; and direct injury to the brain. He must also be aware of the fact that a fracture of the skull may take place without producing any cerebral disturbance; for example:

A man æt. 27 received a blow over the vertex from a broken sword. An extensive scalp wound was the result, and a very evident incised wound in the upper portion of the frontal bone, apparently involving only the external table. It was not complicated with the slightest cerebral disturbance, and good recovery followed.

A boy received a compound fracture over the frontal region from the kick of a horse; he had no head symptoms whatever, and he recovered.

In the former case there was an incised wound of the skull, and in the latter an undepressed compound fracture. In neither was the brain materially shaken, bruised, or otherwise injured, and in both a good recovery ensued. Cases such as these, however, are comparatively rare, the more frequent being examples of fractured skull associated with brain symptoms similar to those which have been described under the head of simple concussion—cases in which the functions of the brain are for a time more or less interfered with or suspended, but which have a tendency gradually to return to their normal condition; in which the injury to the skull has been severe enough to break the bone and general enough to shake the brain and cause a suspension of its functions. The importance of these, however, lies in the injury the brain has sustained, and not upon the fracture, the fracture being only a complication; and, so long as there is no depressed bone irritating and compressing the brain, the danger is in no way increased. If, however, in any given instance, the injury is complicated with laceration of one of the large arteries of the bone, such as the middle meningeal artery or large venous sinus, other conditions may arise which produce special symptoms.

Fractures of the Skull associated with Extravasation of Blood between the Dura Mater and the Bone.

As a result of an injury to the skull, whether with or without a fracture, small extravasations of blood between the dura mater and the bone are not unfrequent, and are due to the rupture of some of the small vessels which pass from the dura mater to the bone. They give rise to no symptoms by which they can be recognized, and usually are only discovered after death.

When any large extravasation occurs, the blood comes, as a rule, from either the trunk or one of the branches of the middle meningeal artery, which runs upward in a groove

of the anterior inferior angle of the parietal bone and divides to supply the lateral parts of the base and vault of the cranium, or it may come from a venous sinus. A fissure, therefore, of a bone involving any of these parts may lacerate one of these vessels and give rise to a hemorrhage sufficiently copious to produce symptoms of compression of the brain.

It is well to know, however, that the brain will sustain a great deal of pressure without giving rise to any symptoms, and that several ounces of effused blood rapidly poured out are required to produce such symptoms as are recognizable.

The following is an excellent case to illustrate the accident:

Case.—A man æt. 49, when riding in a gig, was thrown out upon his head. The accident produced a scalp wound over the *left* side of the vertex and some slight insensibility. He got up and walked for half an hour, when he became confused, staggered, and went into a shop, being supposed by the shopkeeper to be intoxicated; but, as he gradually became quite insensible, he was brought to Guy's. When admitted, he was perfectly unconscious and comatose, with dilated pupils, laboring pulse, and slow respiration. Soon afterward he became convulsed, the *right* arm being more affected than any other part; in a few hours it was completely paralyzed. He remained in this condition for two days, and died comatose. After death, upon removing the calvaria, which was fissured in a vertical direction from the middle of the left parietal bone to the jugular foramen, a large clot of blood was seen lying upon the dura mater, clearly proceeding from the middle meningeal artery. This was about two and a half inches in diameter and more than an inch in thickness. It formed a *globular tumor* and caused an extensive depression upon the left cerebral hemisphere, which pressed the longitudinal fissure to the right side. The brain itself was healthy. Prep. 1606[50] in Guy's Hosp. Mus. shows the condition. In Figs. 77 and 78 these points are well seen.

Fig. 77.

Drawing showing Clot (*b*) external to the Dura Mater (*c*) from Laceration of the Middle Meningeal Artery (*a*) following a Fracture. (Drawing 80[20], Guy's Hosp. Mus.)

Such a case may fairly be accepted as a typical example of this form of injury, and special attention should be paid to the fact that the man recovered from the immediate effects or shock of the accident, remained sensible for a definite period, and then gradually became unconscious. In compression from hemorrhage this "interval of time"—provided it be a short time—between the accident and the occurrence of the symptoms is most important from a diagnostic point of view. It is very commonly, although not constantly, present; but when present, it is characteristic of hemorrhage in some form. The symptoms, to be those of compression, must also be lasting; nor must they be mistaken for the "relapsing unconsciousness" of a shaken brain, to which attention has been already directed. The persistency of the symptoms is consequently a valuable diagnostic symptom.

But, it may be asked, how is extravasation of blood outside the dura mater the result of a lacerated meningeal artery to be diagnosed from extravasation of blood either within the cavity of the arachnoid or upon the surface of the brain, or within the brain itself? For under all these varied circumstances the symptoms may appear some time after the accident, and the inference drawn from the "interval of time" is the same in each; under all the symptoms of compression will be identical, for they will be those of apoplexy, and, as in apoplexy, varying in each case; for "when extravasation takes place on the surface or within the substance of the brain, it is accompanied—and, indeed, produced—by lesion of the cerebral texture, which lesion is mostly indicated by paralysis, by irritation and spasmodic action affecting some particular part, by derangement of the pupils, or by other symptoms" (Cock). The surgeon's best guide, however, in forming his diagnosis will always be the history of the case and the nature of the accident.

In uncomplicated cases of hemorrhage *external to the dura mater* the injury is generally a local one, produced by a sharp blow or fall; the brain, as a whole, is not shaken or injured; the symptoms of compression are, moreover, generally very marked and rapidly produced, and the paralysis of half the body is also commonly complete.

In cases of hemorrhage *into the arachnoid cavity or upon the surface of the brain* the injury is mostly of a general character, such as a fall from a height or a blow from a heavy weight, the whole brain having been violently shaken or "concussed," and, as a result, its delicate structure—more particularly that of the base—has been bruised or

lacerated, weak or diseased vessels being very apt to give way, producing hemorrhage. Hemorrhage external to the dura mater may, it is true, be present in these cases of general injury, but it will be complicated with extravasation into deeper parts; and this point of diagnosis is all-important, since in the former class of cases, when the blood is between the bone and dura mater, surgical treatment may be of inestimable value, whilst in the latter it can be of no service.

Fig. 78.

Transverse Section of Skull with Cranial Contents, showing Fractured Skull, Rupture of Meningeal Artery, a Clot of Blood outside Dura Mater, and Compressed Brain. (From Prep. Guy's Hosp. Mus., 1593d.) "A life lost that perchance might have been saved" (Goodhart).

Hemorrhage upon *the surface of the brain* is a very important subject, occurring in variable degrees in every case of severe or general injury to the skull, whether complicated or not with fracture; the brain itself may be not only bruised at the seat of injury, but it will be equally, if not more, injured at the opposite point by *contre-coup*, and this bruising and extravasation is generally found at the base of the brain. The hemorrhage associated with this bruising may be so slight as to give rise to no symptoms and recovery may take place, or it may be so great as to induce symptoms of compression. But when a large vessel of the pia mater is ruptured, the bleeding will be severe; and under these circumstances the blood may spread into all the parts down to the base, covering in the cerebellum and spinal cord.

It is this fact that renders all cases of *general injury* to the brain so serious and tells so powerfully against any operative interference in such a class of cases, the surgeon being quite unable to reach the source of compression by trephining.

Hemorrhage *into the cavity of the arachnoid* is by no means a common consequence of head injury, but it may occur as a result either of a local or direct or of a diffused injury to the skull, and the effused blood may be poured out upon one or both sides of the cerebrum. When the effusion is gradual and not extensive, no definite symptoms of compression will be produced; but when extensive, although symptoms of compression may appear, there will be nothing to indicate the precise position of the hemorrhage.

In patients who have albuminaria or diseased arteries there is reason to think that a slight injury to the head may cause extravasation of blood into the arachnoid, and this fact has an important practical bearing, furnishing a key to the solution of many a doubtful case of head injury.

Pathology has taught us that blood clot may organize and form what are now known as arachnoid cysts, having smooth external surfaces like a serous membrane, which when recent will be soft and pulpy, when old fibrous. They may contain only serous fluid more or less blood-stained, or clots of blood altered by time. Sometimes these cysts are found to be loose in the arachnoid cavity; at others, fixed to the parietal arachnoid. They are usually found *accidentally* after death in those who have suffered from mental disorder or general paralysis, and, although more commonly they exist on one side of the head only, they are sometimes found on both.

Dr. Crichton Browne (*Journal of Psychological Medicine*, December, 1875) tells us that out of 1240 post-mortem examinations made at the West Riding Asylum there were 59 examples of arachnoid cysts—43 occurred in males, 16 in females—and the majority were in the left side. In half the cases general paralysis was the cause of death. Dr. Browne does not think that these cysts have a traumatic origin, but are due to the rupture of a vessel from cerebral hyperæmia.

To Sir Prescott Hewett (*Med.-Chir. Trans.*, vol. xxviii.) must be assigned the credit of explaining how these cysts are formed from a chronic change in previously effused blood. For a full elucidation of the subject, however, we are indebted to Drs. Wilks, Ogle, Bacon, and Sutherland (*Journal of Mental Science*, vols. x. and xi.; *Rep. West Riding Asylum*, vol. i.).

COMPRESSION OF THE BRAIN.

The brain may be compressed in many ways, though there are four special causes of compression: Compression from "*depressed bone*," the result of fracture, simple or compound; compression from the "*extravasation of blood*" into any part of the cranium; compression from the "*formation of matter*" between the dura mater and the bone: and compression from the "*effusion of inflammatory products*" into the brain or its membranes.

The symptoms of compression under all these different circumstances are much alike, although the clinical history of the cases and the date of the appearance of the symptoms after the injury vary in each class. When the symptoms are due to depressed bone, they follow immediately the accident. When caused by extravasation of blood, there is almost always some interval of time between the accident and the accession of the symptoms, although that interval may be but short. When caused by the effusion of inflammatory products into or on the brain, the symptoms generally appear some days after the accident and are gradual: and when the result of the formation of matter between the dura mater and the bone, the symptoms rarely show themselves for two or three weeks after the accident. In both of the latter classes of cases, moreover, headache and other inflammatory symptoms coexist.

The symptoms of compression of the brain are those of apoplexy, and their severity depends entirely upon the suddenness and amount of the compression. The skull may be fractured and the bone depressed, and still no symptoms arise. Extravasation of blood may also take place to a limited degree within the skull and not be recognized. There is good reason to believe, indeed, that a considerable amount of blood may be poured out *slowly* upon the surface of the brain without giving rise to compression, the brain gradually accommodating itself to the pressure. The most marked cases of compression are usually due to rapid extravasation. When the bones are much depressed, or when the brain is *suddenly* compressed by the local effusion of blood, symptoms show themselves, such as complete insensibility, slow, difficult, and perhaps stertorous, respiration, and a full, slow, laboring pulse. In very severe cases the respiration will be of a peculiar *puffing* character. There may also be complete loss of the power of swallowing, inability to retain feces, and retention of urine, incontinence or overflow of urine being the last symptom. The pupils may be either dilated or contracted, but they will be always fixed, and will not respond to light: whereas in alcoholic coma, Dr. MacEwen tells us, "the pupil is contracted when the person is left undisturbed, and it is dilated when an attempt is made to rouse him" (*Glasgow Journal*, January, 1879).

When the brain is widely and uniformly compressed, the symptoms are "general"—*i. e.*, one side is not more paralyzed than the other. When the compression is *localized*, the paralysis is partial and corresponds with the region affected, though when extravasation is extensive the general effect may mask the local symptoms. The best examples of this form of limited compression are found in cases of fracture of the skull from a local injury and extravasation of blood between the bone and the dura mater. The case quoted on page 202 is a good one in point, though the following is probably a better, as it is complete:

J. P——, æt. 46, a painter, having fallen from a height upon his head on a piece of iron, received a severe scalp wound on the right side of the median line of the head, with slight concussion. He was admitted into Guy's under Mr. Cock's care in 1841, conscious, and remained so for eleven hours; four hours later, however, he was found in a state of utter unconsciousness, with stertorous breathing and insensible pupils. He continued gradually to get worse. The left arm and leg when pinched were readily retracted. The right side was completely paralyzed. No fracture could be discovered. Trephining was performed above and behind the anterior inferior angle of the left parietal bone over the trunk of the middle meningeal artery; a large piece of bone was removed. A gush of blood then took place, and a large coagulum was removed from outside the dura mater. The deep stertor at once ceased, and the next day the man moved his right arm and leg freely and recognized his wife. He progressed favorably after the operation, though recovery was retarded by bone exfoliation. He resumed his work and occupation, and continued in good health for *thirteen years*. During this period, however, he had at intervals exfoliation of some portion of the skull at the seat of injury; in the ninth year he had fits, which during the last six years of his life recurred at intervals, the attacks, as Mr. Cock reported, becoming gradually more frequent and severe in their character. Six months before his death he had paralysis of the opposite side of the body to that of the injury; the face was included in the paralysis, and his speech was somewhat affected.

He died after a severe apoplectic fit. After death the brain beneath the injured bone was found softened and adherent to the skull, and it contained a recent clot of three or four ounces of blood, which filled the ventricles. "It appeared probable," says Dr. Wilks, who made the examination, "that a softening had been going on for some months in the middle hemisphere of the brain, involving the contiguous surfaces of the corpus striatum and thalamus, and that at last a rupture of the vessel had taken place, infiltrating all these diseased structures, as well as the ventricles." The trephine opening was filled in by a tough membrane, and around its margins there was evidence that considerable ostitis had taken place (Cock, *Guy's Hosp. Reports*, 1857).

When a patient receives a direct blow upon one side of the head, causing a fracture with depression of the bone, and attended with paralysis of the opposite side of the body and a fixed and dilated pupil on the side of the injury, the conclusion is inevitable that the depressed bone is the cause of the paralysis by producing pressure upon the brain; the depression must, however, be very great to give rise to such symptoms.

When a patient sustains a similar injury, with or without depression of the bone, but followed after a distinct interval of time by paralysis of one side of the body, whether of the injured side or not, it is quite fair to assume that hemorrhage has taken place inside the skull and is the cause of the compression.

In both these cases a local injury is followed by local mischief, causing a local paralysis; consequently, surgical treatment is of great promise.

When a patient receives a general injury to the head—such as commonly results from a fall upon the head from a height or a diffused blow from a heavy falling body—and this is followed directly or after an interval of time by symptoms of compression, whether associated or not with a fracture, the paralysis is, as a rule, general; and even if more complete on one side than another, the injury to the brain is, for the most part, too diffused or extensive to admit of surgical relief. The case is clearly of a mixed nature, contusion or laceration of brain structure being associated with hemorrhage.

Symptoms of Brain Injury.—When a patient suffering from brain shock, with or without a fracture, is unconscious, motionless, and perhaps pulseless, has lost control over the action of the bowels and the bladder, and has a feeble respiration and paralyzed pupils, it is impossible for the surgeon to form any opinion as to the nature of the cerebral injury. These symptoms may be the result of so-called concussion, from which recovery may take place, and not of severe brain contusion; they may be associated with bruising of the brain and extravasation of blood—not sufficient, perhaps, to cause fatal compression of the brain structure, but enough to set up cerebral symptoms, which cannot pass away for many months under the most favorable conditions; or they may be accompanied by severe brain laceration or extravasation of blood upon or into its structure, which will prove fatal by coma. The position of the extravasation has no influence on the symptoms, although it would appear that death is very rapid when it takes place into the ventricles. The primary symptoms of severe concussion and of general compression are identical, and are often not to be distinguished; both may be the result of the same kind of accident. "But," says P. Hewett, "there is this marked difference: in concussion the effects are instantaneous, and in compression from extravasated blood some little—it may be very short—time elapses before the symptoms manifest themselves. In the former, also, the symptoms gradually pass off, but in the latter they become more and more marked."

"The symptoms of concussion may be continued or renewed either by extravasation of blood, pus, or both" (John Hunter, MS., 1787).

"The diagnostic signs of concussion and compression are, no doubt, distinct in a certain sense, yet compression rarely exists as a consequence of violence without concussion, and both are complicated with shock. Further, symptoms of simple concussion may become developed at a later period into those which indicate some more serious lesion; and it is in exceptional cases only that we can identify with any degree of certainty the efficient and sole cause of compression. Thus, in the stunning effects which succeed a blow on the head, if we can rouse a patient from his state of unconsciousness, even for a few moments, if the breathing is calm and noiseless, if the pulse is feeble, the pupils are contracted, and reflex action can be excited, we conclude that the condition is one of concussion. The intensity of the effects of so-called concussions are marked by the character of the symptoms and by their duration. The probable explanation of protracted somnolence and other evidences of brain disturbance is the presence of diffused extravasation of blood over the surface of the hemispheres" (F. Le Gros Clark).

Hemorrhage into Brain with Fracture.—Again, in a general shaking of

the brain, blood may be extravasated into the brain itself; and when the injury has been sufficient to produce fracture, there is no limit to the amount of hemorrhage or its seat. "But in dealing with such cases great caution is necessary in order to avoid, if possible, mixing up cases of apoplexy with those of traumatic effusions. An accident coexisting with an extravasation of blood into the cerebral substance does not necessarily imply cause and effect. The previous condition of the brain or the outpouring of blood from diseased vessels may, in fact, have been the cause of the accident" (Hewett).

On referring to my notes, I see that in a case of brain injury which lived only one hour blood was found filling the ventricles. In another the ventricles were bruised and the septum lucidum lacerated. In other cases blood was poured out into the thalamus opticus or into the corpus striatum.

In all these the brain had been severely shaken, the hemorrhage being doubtless the result of the shake and the cause of death, while the fracture of the skull was merely a complication.

General Summary.—It has been already shown that concussion of the brain too often implies contusion or laceration of its structure, with extravasation of blood, and in the same way compression indicates as severe, if not more severe, injury. Concussion does not by itself produce definite symptoms; and when paralysis, vertigo, sickness, or other such phenomena, arise, the inference is that there is some structural damage to the brain. Compression implies a more severe degree of the same sort of injury, with effusion of blood or depression of bone. Compression of the brain, when not excessive, is seldom the *direct* cause of death. It proves fatal in the majority of cases by being the starting-point of an intracranial inflammation, since it has been proved that blood can be absorbed or encysted and depressed bone may be gradually raised by the brain itself, or the brain may accommodate itself to the pressure.

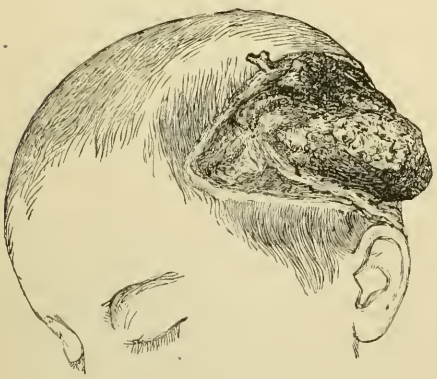
Compression of the brain as a result of traumatic encephalitis will receive attention in a subsequent page.

Wounds of the Brain.

In some injuries to the skull the brain may be wounded or lacerated, and brain matter may even escape from the wound directly after the accident. Such accidents are always of a very grave nature, and, as a rule, fatal. Wounds of the anterior and upper portions of the hemispheres are the least dangerous; wounds of the posterior hemisphere or base of the brain, the most so. Recovery may, however, at times follow very severe injuries when no secondary inflammation takes place.

When brain matter is pressed out of the skull in cases of fractured base, a grave injury is always indicated, since the crushing force must have been severe to have given rise to such a complication. Some remarkable instances of recovery after the escape of brain matter are, however, recorded; and several have passed under my own observation, but they are too rare to be dwelt upon as holding out any hope in bad cases. Foreign bodies may likewise lodge in the skull for a long period without causing death. Wounds of the brain are not characterized by any special symptoms apart from those of concussion or compression.

Fig. 79.



Hernia Cerebri.

Wounds of Dura Mater.—Wounds of the dura mater are probably as dangerous as wounds of the brain, for inflammation of the membranes is readily set up by such injuries. It is from this fact that compound fractures of the skull are so serious, that simple fractures associated with comminution of the inner table of the skull are so often fatal, and that punctured fractures have so dangerous a tendency; for in all these cases the dura mater is not only torn, but irritated, by the projecting spiculæ of bone, and secondary inflammation is the result. This inflammation, as a rule, rapidly spreads over the brain and causes death.

Prognosis.—Wounds of the dura mater, as well as wounds of the brain, are sometimes recovered from, but the prognosis in either case must be unfavorable.

Hernia cerebri, or protrusion of brain matter alone, or brain matter mixed with

inflammatory products, is always the result of a wound or slough of the dura mater secondary either to a compound fracture or to the removal of fractured or diseased bone. It is probably always associated with some suppuration (local) of the brain, due to extension of inflammatory mischief to that part in contact with the diseased dura mater and bone. It is to be treated with great caution. Some surgeons are in the habit of cutting off the projecting mass, others of applying pressure; but probably the best practice lies in doing very little, in keeping the parts clean and dry, and leaving their repair to natural processes. If the local affection be so limited in its nature as to be capable of repair, the projecting mass will slough naturally after a time, and cicatrization will follow; whereas interference on the part of the surgeon does harm. The best treatment is at first to apply a piece of lint to the part, and at a later stage to keep the hernia dry by dusting it with oxide of zinc or powdered alum. Excision and the application of caustics or pressure do not appear to be satisfactory forms of treatment.

The experience of army surgeons during the American war confirms these observations.

INFLAMMATION OF THE CRANIAL BONES, BRAIN, AND MEMBRANES THE RESULT OF AN INJURY TO THE HEAD.

In all cases of injury to the head, simple or severe, attended or unattended by fracture, in all cases of concussion, contusion, compression, or laceration of the brain, or of injury to the dura mater, inflammation of the bones, of the brain, or of its membranes is liable to arise; and when it does, it is a very grave complication. It is this fact which makes all injuries of the head, even simple contusions of the bone, sources of danger, because inflammation, commencing in the bone, too frequently spreads inward to the membranes of the brain and to the brain itself, and thus destroys life. The free communication between the pericranium and the dura mater by means of the blood vessels of the diploë is a probable explanation of this occurrence in simple scalp and bone contusions. In injuries to the bones of the skull and to the brain or its membranes, the liability to encephalic inflammation appears to be greatly determined by the severity of the accident.

In the present chapter, traumatic encephalitis, *acute* and *chronic*, as the result of brain shocks, whether with or without a fracture, will claim attention.

The *acute* or diffused form of arachnitis is the cause of death in most of the cases of head injury that survive the immediate results of the accident.

These cases, for the most part, are the result of a severe *general* shaking of the brain, with or without fracture, complicated with contusion or laceration of the brain structure or its membranes. They are consequently cases of arachnitis and inflammation of the brain substance itself, the inflammation of the membranes being general. "I have never known," says Wilks, "such an affection as arachnitis spring up as a spontaneous disease; and therefore, when met with, you should always look for some mischief without. When arising in this way, the interarachnoid effusion is often purulent and so copious that it may pour out when the dura mater is removed. I have never seen extensive effusion into the interarachnoid space without an injury on the head."

Chronic Result of Injury.—The *chronic* cases are, for the most part, the result of a *local* injury and begin in the bone, spreading inward to the dura mater, and at last involving the two layers of the arachnoid membrane, the pia mater, and even the brain itself. Localized suppuration is frequently found in these cases, either between the bone and dura mater or in the brain itself, from extension of inflammatory action from without inward. The same localized changes may take place in all cases of chronic ostitis of the calvarium, whether from accident or disease.

The symptoms of the acute affection appear in the stage of reaction; indeed, they may be looked upon as indicating reaction in excess, febrile symptoms, headache, convulsions or convulsive twitchings, delirium or mania more or less acute, terminating rapidly in paralysis, coma, and death, being the general order of symptoms. Effusion of serum takes place into the ventricles and upon the brain, causing at times compression, or effusion of pus or puriform lymph occurs either upon the brain itself or in the meshes of the pia mater, or into the cavity of the arachnoid.

Whenever the brain has been severely shaken, and consequently bruised or lacerated, inflammation may appear at the injured spots; hence it at times shows itself *beneath the seat of the blow*, but more frequently begins on the opposite side of the brain to the seat of injury where the brain has been *bruised or lacerated by contre-coup*. From these centres inflammation may spread either to the membranes from the cortical structure of the

brain or to the substance of the brain itself; thus, in all cases of a general shaking of the brain, the seat of inflammation is in most cases at the base of the brain. The pia mater and cortical substance of the brain are commonly the seats of inflammation, but the cavity of the arachnoid is likewise involved in many cases secondarily by extension of the morbid action. There are no symptoms by which the precise seat of inflammation in the brain or its membranes can be made out; they are alike in all cases.

In chronic encephalitis the symptoms may show themselves soon after the injury, but, as a rule, they do not appear for weeks, or even for months. They are most insidious in their nature; they may begin by want of sleep, with an irritability of brain and inaptitude for any bodily exertion, but headache of a constant exhausting kind, aggravated by mental or physical exertion, is a most prominent symptom. As the disease progresses the patient gradually becomes emaciated and exhausted, and toward the close of the case epileptiform convulsions, local paralysis, and coma supervene.

It will thus be seen that the two classes of cases of acute and chronic encephalitis are distinct in a measure. The *acute* is the result of a bruising of the brain by a severe shaking or concussion, the bruising being, as a rule, at the base of the brain by *contre-coup*. The inflammation begins in the pia mater, spreads outward, and is for the most part diffused, and not local. Consequently, it is *beyond* the reach of surgical operation. The *chronic* is generally the result of contusion or fracture of the bone and local in its action. It involves, by extension from without, the dura mater, the arachnoid, pia mater, and brain consecutively in the same way. It is consequently *within* the reach of surgical art, particularly in its early stage.

Treatment.—Acute encephalitis, when following a general injury to the brain, for the most part runs such a rapid course that there is little time for treatment to take effect. It attacks patients, moreover, who have been already knocked down by the injury, in more ways than one, in whom there is rarely much resisting force; and there is, consequently, not much chance of success by treatment. Still, there is much to be done.

The head must, of course, be shaved and raised on a pillow, and cold should be applied to it by means of one of Leiter's coils (Fig. 9, p. 49), or an ice-bag where the former instrument cannot be obtained. The ice, when applied in a bag, must be broken up into small fragments; while the bag containing it should be large, in order to cover the whole vault of the skull. The cold douche is also a powerful remedy. Free purging should be resorted to, the old dose of calomel mixed with butter introduced into the mouth being probably the best mode of administration, or an enema of turpentine or castor oil may be administered.

In a strong man, when symptoms of acute encephalitis appear after a slight injury, bleeding is a most valuable practice. It should be performed boldly and freely at the first onset of the symptoms, so as to take effect upon the patient, during the state of excitement, before effusion has taken place and brain oppression appeared, and it may be repeated. In severe general injuries it is useless. Some employ leeching and cupping on the nape of the neck, and speak highly of the practice.

French surgeons still employ blisters to the scalp, but these cannot be compared in value with bleeding and the local application of ice in the early stage of the affection. In the chronic stage they may be beneficial. When they are employed, they should be applied to the nape of the neck, and, where mercury is relied upon, the latter may be used in the form of an ointment to dress the blister. Antimony is still given by some surgeons of eminence. I have no experience of its use, and therefore cannot recommend it. When recovery takes place—a rare result—the patient must be cautioned as to the future; for any excess of diet or of mental or physical exercise may produce a relapse. The greatest quiet ought to be observed for many weeks, and the patient should live on the simplest food. Milk diet and animal broths are sufficient for some time, solid animal food being taken with great caution. Stimulants should only be administered if the patient's powers are feeble.

In chronic cases calomel, given in small and repeated doses to touch the gums, combined or not with opium, has its advocates, and patients, doubtless, have recovered under its use. The gray powder in three- or four-grain doses, with five grains of Dover's powder, is a useful combination when delirium is present, and at times larger doses of opium or morphia may be given. Great care, however, must be observed in the use of these drugs, for, unless they are carefully given and their effects watched, they are injurious.

When symptoms of compression of the brain follow those of *acute* encephalitis the result of a *general injury* or shaking of the brain, there is little doubt that its compression is due to the effusion of inflammatory fluid into, upon, or beneath the brain; and under such circumstances the question of surgical interference should not be entertained. Such is to be thought of only in cases of local *chronic* suppuration the result of a local contusion of the bone or other injury, or of disease, and when the seat of suppuration is usually between the bone and the dura mater. At times, however, a local abscess is formed in the cavity of the arachnoid; and under the circumstances when strong evidence of this condition exists the parietal layer may be punctured, since good results have followed this practice.

Puncturing the Brain for Suppuration.—In more advanced cases suppuration may involve the brain itself, and it is a serious question whether a surgeon is ever justified in puncturing this organ with a view of laying open the suppurating cavity. Should, however, good evidence exist of suppuration in the cerebral hemisphere beneath the seat of injury, I have no doubt as to the surgeon being justified in making an exploratory puncture; for Mr. Holden has recorded in *St. Bartholomew's Hosp. Rep.* for 1873 a case, and Mr. Hulke others, and in the *American Journ. of Med. Science* for July, 1873, five other instances may be referred to in which success followed this practice. Dupuytren had a successful case of the kind, and pathological anatomy furnishes examples in which such a practice might have been of use. On the other hand, many bold attempts are on record in which surgeons have punctured the brain to relieve symptoms of suspected suppuration in its substance. Weed's case is without doubt the best, as it was successful (*Nashville Journ. Med.*, April, 1872), but Detmold's and Maisonneuve's are encouraging.

I am disposed to think that surgeons are too apt to leave these cases alone too long and allow them to get beyond relief.

A man receives a blow upon the head, followed by passing symptoms of so-called concussion; he has a slow convalescence, attended, and perhaps followed, by headache. He may display some irritability of brain, inability to do much work or to undergo any physical fatigue; some febrile disturbance may perhaps manifest itself, but as often as not none appears. The pulse probably will be feeble and irritable, at other times slow and laboring. On examining the seat of injury tenderness on pressure may be experienced, and occasionally increase of heat will be felt. Pressure upon the injured part may even excite a convulsion where such had previously occurred. Under these circumstances, which are fairly indicative of local inflammation of the bone, spreading inward—though how far is uncertain—a free incision to the bone is of great value. I have known this operation relieve immediately all the symptoms, general and local, and have never known it followed by harm. It should always be performed when evidence of local inflammation exists, with undefined and persistent brain symptoms.

Symptoms of Abscess beneath Bone.—When, however, evidence exists that the inflammation has spread from the bone to the parts beneath, as indicated by symptoms of feverishness, severe headache, and probably rigors, with sleeplessness, delirium, convulsions, and paralysis, particularly when hemiplegic, other surgical treatment may be thought of; for if these symptoms are associated with such a history as has just been sketched, there is every probability that suppuration exists within the skull and that surgical art may reach it. General treatment, moreover, in these cases is both unsatisfactory and unsuccessful; and if the case be left alone, bad results always follow. Surgical interference, it is true, as a rule, is not very satisfactory, though some striking examples of success exist. In the hands of Pott trephining the skull for matter beneath the bone outside the dura mater yielded a good result in five out of eight cases. No modern surgeon, however, can show a like success; "indeed," says Sir P. Hewett, "the successful issue of a case of trephining for matter between the bone and dura mater is, I believe, all but unknown to surgeons of our own time." Nevertheless, the operation is clearly justifiable under such severe circumstances as have been described; for our want of success is probably due to the fact that surgeons are too readily disposed in these cases of local encephalitis to wait too long, to trust too far to nature's own processes, and by so doing to allow the local suppurative action to spread inward beyond the dura mater to the brain itself, when the prospects of a successful result are certainly poor. They wait for what are called well-marked brain symptoms—coma and hemiplegia—before they interfere: which well-marked symptoms too often mean fatal brain complications. Trephining the seat of injury, therefore, under such circumstances is clearly a justifiable, if not a hopeful, measure, should the operation be performed as soon as it is manifest from the history of

the case that the local action is spreading. When pus is found between the bone and the dura mater, great hopes may be entertained of a successful issue, although, when the same suppurative action has involved the cavity of the arachnoid and the brain, the prospect is not good.

Should no pus be found, however, between the bone and dura mater, is the surgeon justified in opening the membrane? Without doubt he is when there is strong reason to believe that pus exists, when the dura mater on exposure *bulges* firmly into the opening in the bone which has been made with the trephine, and is *tense* as well as absolutely *pulseless;* for cases of success after this operation have been recorded by Guthrie, Roux, Dumville, and Hulke. The evidence required to sanction any incision into the brain in search of suppuration, as has been already stated, must be very strong.

Acute encephalitis as a result of blood poisoning needs only to be mentioned. It is a hopeless condition from the first, and is always associated with the worst and most general form of pyæmia.

TREATMENT OF CONCUSSION AND COMPRESSION OF THE BRAIN, AND OF FRACTURES OF THE SKULL.

"A mere crack in one of the bones of the cranium, *abstractedly considered*, is not more likely to produce any serious complaints than a simple fissure in any other bone; and if symptoms of consequence do frequently attend the accident, they proceed either from the bone being beaten inward, so as to press upon the brain, or from the mischief done to the parts within the skull by the same force that broke the bone itself. The same violence which breaks the cranium may occasion a concussion of the brain, an extravasation of blood in or upon it, or subsequent inflammation of that organ, and its usual consequences" (Sam. Cooper).

The truth embodied in this extract renders it necessary to consider the treatment of head injuries as a whole, since it is impossible to say, in any case of severe injury to the skull, whether two or more of the conditions mentioned are not associated.

When brain concussion has taken place, it may or may not be associated with fracture, and it may or may not be followed by symptoms of compression, either from extravasation of blood or secondary inflammation; and when a fracture is known to exist, either with or without depression of bone, the difficulty is not lessened. The symptoms may be a mere temporary suspension of the brain's functions—or, as they are commonly called, those of a passing concussion—or they may be of a much more serious nature and such as indicate brain contusion, laceration, or blood extravasation. The severest complications are often ushered in by the mildest symptoms, and therefore the surgeon should always treat every case of injury of the cranium and its contents as serious. He should also be as guarded in his prognosis as he necessarily is uncertain in his diagnosis.

In any case, therefore, of concussion, however slight, the patient ought to be kept quiet, and should observe moderation in diet, take little or no meat, and avoid all stimulants. If he moves about, it is at a risk—a risk of fatal secondary inflammation of the shaken or bruised brain. These precautions should be continued for at least three weeks.

In severer concussion, in which, after an injury to the head, there is a more or less complete suspension of the functions of the brain, whether with or without a fracture, equal care is needful. Should the collapse indicative of the first stage be severe, reaction may be hastened by means of warmth to the body generally, more particularly to the feet, and by the application of some stimulant to the nostrils. It is seldom right to do more than this, because, if reaction does not set in naturally and is not hastened by the means mentioned, it is tolerably certain that the brain mischief is of a severe, if not fatal, character. Under these circumstances, any more powerful means, such as the administration of alcoholic stimulants or powerful enemata, are likely to excite reaction to excess and either encourage secondary hemorrhage or inflammation within the skull.

Reaction and its Treatment.—When *reaction* has set in after the collapse—the *second stage* of authors—every source of excitement, mental or physical, should be removed. The patient should be kept in bed with his head raised and shaved, and the bowels emptied with a mild saline or mercurial purge. Leiter's coil (Fig. 9), cold lotions, or an ice-bag should be applied to the head, and particularly if it be hot, the pulse rapid, and other symptoms of general febrility and brain excitement show themselves. When the symptoms of excessive reaction are persistent, the commencement of traumatic encephalitis should be suspected; and under such circumstances venesection, boldly performed, is a valuable remedy. It may even be repeated should the symptoms return and the pulse

and temperature rise. In feeble patients, however, bleeding is inadmissible, and under all circumstances it ought only to be resorted to after careful consideration.

The diet should be liquid and of a simple kind. Milk, when it can be taken, is the best; but when it cannot, weak beef tea or broth should be given, and then only in moderation.

Treatment of Fracture and Concussion.—Concussion of the brain complicated with either simple or compound undepressed fracture of the vault or fracture of the base is to be treated upon like principles and with equal persistency and care, for simple fractures of the vault, compound fractures of the vault, and simple fractures of the base, or of the vault and base combined, *unassociated with displacement*, require no special treatment beyond that indicated by the brain symptoms.

It should be here stated that the treatment of all these conditions is to be continued for at least a month or six weeks after the injury, since there are many cases on record in which secondary inflammatory symptoms appeared at least a month after the accident or after the subsidence of the primary symptoms.

Treatment of Compression.—When the brain symptoms following an injury to the head partake more of the nature of compression—that is, when they are persistent in their character, and, instead of going on toward recovery or to the restoration of the natural functions of the brain, tend rather toward their more complete abeyance—other questions of treatment come before the surgeon; and the most important has reference to the fact whether surgical art can do anything toward relieving the condition.

The student who has carefully read the remarks that have already been made can now understand, when the injury to the brain or skull has been the result of some *general injury*, such as a fall upon the head from a height or a blow from a heavy body, that the brain mischief which follows is certain to be of a general character; and when symptoms of local mischief complicate the case, little good is to be gained by treating these local symptoms when others of a more general or fatal character exist. In examples of brain or skull injury, therefore, as a result of diffused or general shaking of the head and its contents, local interference of any special character is generally useless.

In *local* injuries, however, the question may be seriously discussed.

In cases of *depressed fracture*, ought the bone to be elevated? and should the fact of the fracture being compound influence the decision? I have no hesitation in answering both questions and asserting that in neither instance ought surgical interference to be adopted as a rule of practice, since experience has taught us that depressed bone *per se* may exist to a great degree without giving rise to any serious brain complications, and that when even brain symptoms follow as an immediate result of the injury they may all pass away.

Extravasation of Blood between Bone and Dura Mater.—Should, however, the symptoms indicate the presence of effused blood beneath the fracture sufficient to cause compression of the brain, as shown by the lapse of an "interval of time" between the accident and the symptoms, and should local paralysis point out its seat, surgical interference is called for; and in both simple and compound fractures the trephine may be required in order to elevate the bone. The operation is necessary on account of the brain symptoms present in the case and has no reference to the character of the local injury—to the presence or absence of a scalp wound.

In cases of simple fracture in which brain symptoms exist a free incision down to the injured part for purposes of exploration is often called for.

In *compound fracture* of the skull, however, associated with *depression and comminution* of the bone, both with or without brain symptoms, the surgeon ought to remove loose pieces of bone and may elevate the depressed portions when this can be done with the elevator without difficulty, as splintered bone is always a dangerous body when in contact with the dura mater.

When the brain is injured, the same course should be followed, the greatest care being observed not to add to the irritation by any rough manipulation. Should difficulty be felt, however, in removing bone, it had better be left *in sitû* rather than by interference incur any extra risk of injuring the brain or its membranes.

Should there be, on the removal of bone, severe hemorrhage from a meningeal artery, the piece should be left; and should this practice fail to arrest the bleeding, a small piece of sponge or plug of carbolized catgut inserted beneath the bone may succeed, or the application of a pair of spring forceps may be called for. It is not often, however, that such a complication is met with.

In every case of *punctured fracture* of the skull trephining should be resorted to.

General Summary to Surgical Interference.—It thus appears that in simple or compound *uncomminuted* depressed fracture from a local injury operative interference is not called for unless associated with marked symptoms either of compression of the brain or extravasation of blood between the bone and the dura mater; whereas in compound *comminuted* fracture and in *punctured* fracture, with or without symptoms of brain compression, the bone should be elevated and all fragments removed. In other cases, as in fracture of the base, no surgical interference can be justified.

Did space permit, many instances might be quoted to illustrate these points, for cases of fracture of the skull with depressed bone without brain symptoms in which recovery has taken place are numerous; indeed, experience has proved that there may be much depression of bone without brain symptoms, and I am tempted to believe that depressed bone by itself never gives rise to marked symptoms of compression, and that when these are present hemorrhage exists with it.

Many cases might also be quoted illustrating the value of surgical interference in compound fractures with depression; I give the following:

Compound fracture of skull with depression from local injury. A feeling of permanent weight on the head was the only symptom, which was at once relieved by removal of the bone, and recovery followed.

Compound fracture of skull with depressed bone from local injury. Constant vomiting and pain in the head, which was relieved at once by removal of the bone, the patient recovering on the fourth day.

Compound fracture of skull with depressed bone from local injury. Persistence of symptoms of oppressed brain. Elevation of depressed bone, and rapid recovery.

THE OPERATION OF TREPHINING OR FOR THE ELEVATION OF DEPRESSED BONE.

"Much has been written and said on the treatment of injuries to the head, and the result of modern experience and judgment has so far altered the practice of our predecessors as to render us cautious of inflicting an additional injury on our patient for the sake of gratifying an impertinent and useless curiosity as to the exact nature and extent of the original lesion." Thus wrote my colleague, Mr. Cock, forty years ago: and what he then said is true now, although, perhaps, surgeons at the present day are less disposed to trephine in head injuries than they were even at that time.

At Guy's Hospital trephining and elevation of bone for head injuries have been performed in fifty-one cases during seven years, and of these only twelve recovered. At

FIG. 80.

Showing the Operation of Trephining.

A, Trephine prepared for use, with centre pin down.
B, With centre pin withdrawn, the outer table having been divided.

FIG. 81.

Elevator.

FIG. 82.

Hey's Saw.

St. Bartholomew's Hospital it was recorded by Callender in 1867 that the operation had not been performed for six years. At University College, Erichsen gives six cases of recovery out of seventeen.

The operation is, however, valuable in two classes of cases:

First. To relieve compression of the brain due to either depressed bone or extravasation of blood.

Secondly. To prevent, check, or relieve irritation of the brain or its membranes when caused by (1) depressed and comminuted bone, by (2) inflamed and swollen bone (whether the result of accident or disease), or by (3) an accumulation of pus between the bone and dura mater compressing the brain; and it may be stated at once that the operation of trephining gains more support from the second than from the first group of cases.

With respect to the first, it will have been gathered from preceding chapters that depression of the bones of the skull is rarely sufficient of itself to give rise to persistent symptoms of compression; that when it is, the injury has probably been of such a severe nature as to produce grave intracranial complications from which any operation would be incapable of affording relief; and that hemorrhage between the bone and the dura mater is rarely so uncomplicated with brain mischief as to render it probable that the operation of trephining will be successful.

When, however, it can be fairly determined that brain symptoms of a defined and aggravated character are the result of either of these two causes, separately or combined, the operation of trephining may be performed. In diffused injuries to the skull the probabilities are all against the operation, while in local injuries they are in its favor.

In both simple and compound fractures of the skull, with or without depression of bone, the symptoms of compression of the brain as a primary result of the accident must be very marked indeed to justify the operation of trephining, although in *compound fractures* it is expedient to elevate depressed bone when any symptoms of brain irritation manifest themselves, such as local pain and weight, spasms, or convulsions; and under all circumstances it is best to remove fragments when the bone is comminuted. In a compound comminuted fracture of the skull the dura mater is probably exposed, and is likewise irritated by the broken bone. A careful elevation of the depressed portion of the bone and the removal of the comminuted fragments can in no way add to the mischief, but must tend toward its diminution.

In *local injuries*, whether simple or compound, when incipient symptoms of brain irritation or inflammation appear two or three days after the injury, the use of the trephine is indicated, inasmuch as there is a probability that the symptoms originate in the presence of a fragment of bone irritating the brain or its membranes, which, if left, must set up encephalitis.

In all cases of *punctured fracture* the trephine should be employed.

Pus between Dura Mater and Bone.—When an abscess can be made out as existing between the bone and the dura mater after a head injury, the operation of trephining is demanded, though the diagnosis of such cases is difficult. The chief indications are found in the prolonged period which frequently elapses between the injury and the supervention of the symptoms, their gradual and, it may be said, irregular approach, the general and cerebral irritation that is present as a rule, the exacerbation of all these symptoms, and, above all, the constant headache.

The direct symptoms of compression produced by the formation of pus are, moreover, in no ways so definite as those afforded by blood extravasation; they are of a less decided nature and are never associated with the deep-toned stertor and rapid progress of the symptoms, "which with overwhelming influence quickly annihilate both motion and consciousness when blood has been poured out in any considerable quantity after injury to the cranium" (Cock). They are, however, fairly marked by the clinical history of the case, and can be generally recognized.

The Operation of Trephining.

The instruments required for the operation are the *trephine*, or circular hand-saw, of which there are two sizes; a *small saw* with a straight and circular edge, generally known as Hey's saw; a *sharp scalpel* with a handle rounded at the end, to press back the periosteum and soft parts from the bone; a *flat probe* thin enough to introduce into the groove made by the trephine, to guide the surgeon in his attempt to perforate the bone and to prevent him going too far; a pair of *cutting forceps*, to remove sharp points and edges of bone; *an elevator*, to raise depressed bone; and dissecting, dressing, and torsion forceps. (*Vide* Figs. 81 and 82.)

The patient's head having been placed upon a pillow, *shaved* so far as requisite, and held firmly, the first thing the surgeon has to do is to expose the bone he wishes to perforate or elevate. This must be done freely, either by enlarging the wound that pre-

viously existed or by an incision crucial or otherwise. The soft parts should be divided by one cut down to the bone, and these, including the periosteum, should be gently pressed back with the handle of the knife. Bleeding at this stage should be arrested by ligatures, torsion, or the application of a cold sponge and pressure.

Supposing the case to be one of fracture with depression, and that fragments of bone exist, they should be removed, great care being taken in their removal not to twist the broken bone and thus run the risk of tearing the dura mater; and when an opening is thus formed, the depressed bone may be raised by means of the elevator carefully introduced beneath its free border. To facilitate this proceeding, perhaps the removal of a piece of projecting bone by forceps or Hey's saw will be found beneficial; and if so, the trephine is not required, for the surgeon's object, under the circumstances—to raise the depressed bone and remove the comminuted portions—may be completed without the trephine.

Should the bone be so depressed, however, as not to present an edge for the surgeon's forceps, as is seen in the "gutter" fracture illustrated in Fig. 71, the trephine must be employed. The instrument should be previously prepared, the central pin being made to project sufficiently far to perforate the external table, and so fixed as to allow the saw to bite the bone (Fig. 80, A). In a depressed fracture this pin *should never be placed upon the fractured*, but upon the border of the sound bone. The instrument is then to be applied and the external table cautiously divided with a few semi-rotatory movements of the surgeon's wrist. A groove having been made deep enough to allow the saw to work steadily, the instrument is to be removed and the central pin withdrawn and fixed (Fig. 80, B), as it would be a fatal error to go on working with the pin projecting through the inner plate of bone into the dura mater. The surgeon ought now to proceed with the utmost caution, and feel his way every few turns with the flat probe, for as soon as he has divided, or even reached, the inner plate, the elevator may be employed and the loose ring of bone removed. When the inner plate is fractured to a greater extent than the outer, it may not be necessary to divide it, the removal of the external table with the diploë being sufficient to allow of the introduction of the elevator and the removal of fragments. Should this not be the case, however, the inner table must be perforated; for the whole thickness of the bone must be removed. The operator cannot be too careful at this stage of the operation, and should always proceed with the conviction that the bone is thinner at one spot than another, and, further, that "there is only the thinness of paper between eternity and his instrument" (Sir A. Cooper's MS. lectures). The depressed bone may then be raised by the elevator.

If the operation has been performed for extravasation of blood beneath the bone and a clot be discovered, it should be removed, the utmost gentleness being used. Should pus exist, it will escape naturally.

Should troublesome hemorrhage from a meningeal artery ensue, it may be arrested by tucking a small portion of sponge or carbolized catgut beneath the vessel and compressing it against the bone, or it may be held by a short pair of spring forceps against the bone. Free bleeding of this kind, however, is not frequent.

On Puncturing the Dura Mater.—If, however, no blood or pus be found external to the dura mater, and strong evidence exist that it is placed beneath this membrane, the dura mater may be punctured. This step, however, is not to be undertaken without grave consideration. Yet, it may be asked, if the operation fail in its object, is the operator ever justified in making a second opening into the skull in search of blood or of pus? Certainly, it must be answered, not at a hazard; although, when there is evidence to point to a second position in which it is reasonably probable that the offending fluid may be found, a second perforation may be performed. Cases are on record in which three or more pieces have been removed with a good result.

The wound, after the operation, must be treated on general principles, the edges of the soft parts being gently brought together, but not stitched; boracic acid lotion on absorbent cotton is the best dressing, and the head should be kept cool by the ice-bag. If the parts heal and the case does well, a metallic shield may be required as a protection, although it is interesting to see how firm the membrane that fills in the cavity becomes after a time.

Hernia Cerebri.—Should a hernia of the brain follow at a later stage, the same local treatment should be employed. Excision of the projecting fungous mass is a practice that is not advisable. The whole will probably wither by natural processes if a cure takes place; and the less the surgeon interferes, the better.

General Conclusions on Injuries of the Head and their Treatment.

1. Injuries of the head are of importance only so far as they primarily or secondarily involve the cranial contents, a case of simple uncomplicated fracture of the skull being of less danger than one of general concussion of the brain.

2. A slight shaking of the brain, which manifests itself by a passing suspension of the cerebral functions, associated or not with a fracture of the vault or of the base of the skull, generally does well.

3. A severe concussion or shaking of the brain associated or not with a fracture of the vault or of the base of the skull is probably associated with contusion or laceration of the brain substance, either upon its surface or within its ventricles, and consequently with more or less extravasation of blood; when the vessels are diseased, a copious hemorrhage often follows a slight injury.

4. In cases of severe concussion the brain is at least as much injured by *contre-coup* as it is at the seat of injury, its base suffering the most. Fracture by *contre-coup* does not take place.

5. A fall upon the vertex from a height or a blow upon the head from a blunt instrument may or may not be followed by fracture of the skull, but such an accident produces, as a rule, a general concussion of the brain, with contusion or laceration of its structure and effusion of blood either upon its surface or within its substance or ventricles.

6. Falls upon a pointed object or blows with a sharp instrument are, as a rule, followed by local fracture; and if the brain be injured, it is at the seat of injury. As a consequence, the symptoms may be accounted for by local causes only, and the surgical treatment should be directed by local considerations.

7. When symptoms of compression of the brain immediately follow an injury to the skull which has been produced by a fall from a height or by a blow from a heavy and blunt instrument, the cerebral injury will be general, the brain will be contused and lacerated, particularly at the base, by *contre-coup;* and if extravasated blood be found external to the dura mater, blood will also be found upon the surface of the brain or within its membranes. The operation of trephining under these circumstances can be of no avail.

8. If symptoms of compression of the brain follow a local injury produced by a fall upon a sharp object or a quick blow from a pointed one, such symptoms, as a rule, are produced by local causes, such as depressed bone or extravasation of blood from a ruptured vessel, and such local injuries should be treated by the elevation of the depressed bone or by trephining.

9. When compression of the brain follows a local injury over the course of the meningeal artery, and the symptoms come on after reaction has been established and the lapse of an interval of time from the receipt of the injury, the operation of trephining may be performed, although no depressed bone be present.

10. Encephalic *inflammation* may follow the slightest concussion or injury to the brain, whether complicated or not with fracture; and the danger of such a result is in proportion to the encephalic injury. In cases of contusion or laceration of the brain with extravasation of blood, inflammation is almost sure to occur, and, as a rule, will cause a fatal termination. This inflammation may appear within a few hours of the accident or it may be postponed for days; it may be very rapid in its course or very insidious in its nature. If the brain alone be affected, either a diffused or local abscess may result; while if the membranes are involved, effusions, convulsions, general or partial paralysis, coma, and death will rapidly take place.

11. Fractures of the base of the skull may take place alone and be marked by only special symptoms. They may be associated with, and are generally found in, all cases of severe fracture of the vault when produced by a heavy fall or blow, the fissures radiating downward in a direction parallel to the forces employed.

12. Fractures of the base may be complicated with encephalic injuries similar to those which complicate fractures of the vault; consequently, they may be manifested by general as well as special symptoms, and in severe cases the former completely mask the latter.

13. All injuries to the head should be treated with extreme care and always regarded as serious, rest in the horizontal posture, freedom from excitement, bland, nutritious, unstimulating food, being essentials under all circumstances, the great principles of practice consisting in warding off excess of reaction and inflammation of the cranial contents.

DISEASES OF THE SCALP AND CRANIUM.

Besides the blood tumors of the scalp to which attention has been already directed, the head is very frequently the seat of the common skin or *sebaceous tumor* which is called a "wen," these morbid growths being more frequently found on the head than on any other part of the body. They are more common also in women than in men, seventy out of one hundred and seven consecutive cases of sebaceous cysts which I have analyzed having occurred in women and eighty-four on the head. In many instances these wens are doubtless due to an obstruction of the duct of a sebaceous follicle, as the orifice of the duct is often visible and through it the contents of the cyst can be squeezed; while in others no such obstruction can be made out, it being probable that some of these tumors are new formations—true adenoid tumors of the skin, such tumors usually lying beneath the skin, but without any connection with it. These cases have, however, been fully considered at page 144.

The scalp may likewise be the seat of other tumors, *simple* or *malignant*, of *epithelial* cancer of the skin, or of any other affection of the integument. These require no special attention here.

Nævi are very common in all their forms—cutaneous, subcutaneous, or mixed; but this subject will be considered in another chapter. Let me caution the student, however, not to adopt hastily any surgical proceedings with a nævus situated over a fontanelle; for, although such may be dealt with with impunity, I have known a fatal inflammation attack the membranes of the brain after the application of a ligature to an undoubtedly cutaneous nævus placed over this region. If possible, he should wait till the bones have closed before he interferes.

Perforating tumors of the skull occasionally come under the surgeon's notice, and demand attention. The majority of them have their origin from the membranes covering the brain, and mainly from the dura mater. They are generally *cancerous* and are often secondary deposits, though occasionally they seem to be of the "sarcomatous" nature. They were first described by Louis in 1744 under the term "fungus of the dura mater" (*Mém. de l'Acad. Roy. de Chir.*, tome v.). Since his day all perforating tumors of the skull have been included under this heading. It must be remembered that a tumor growing within the skull and pressing outward will cause absorption of the cranial bones; which fact is rendered familiar to pathologists by the enlargement of the Pacchionian bodies.

Symptoms.—The symptoms indicating the presence of this affection are very uncertain, although headache more or less constant and severe may exist with epileptiform convulsions and other brain symptoms; yet as often as not the first marked condition to which the patient's attention is directed is a swelling in one of the bones, the disease having progressed thus far without having given rise to any symptoms whatever. When the diseased mass has perforated the bone, the swelling, receiving its impulse from the brain, will be pulsatile; and this symptom is of importance as a distinctive one between tumors of the bone itself and the perforating tumors of the membranes. In cancerous disease the bone itself will be infiltrated with cancerous elements and destroyed, while in benign tumors the bone will be absorbed simply by pressure, as is seen in aneurism. In the former case the opening in the bone will be ill-defined and irregular, and in the latter it will be smooth as well as regular.

Treatment.—With respect to treatment, it is almost needless to say that nothing can be done by way of removal of the growth. The symptoms to which it gives rise can only be relieved by sedatives, and life can only be prolonged, if at all, by general treatment.

The bones of the skull are liable to tumors, cancerous or benign, to exostoses, particularly of the ivory kind, and to myeloid growths, though in this place it is only necessary to mention the fact.

Meningocele and Encephalocele.

These terms are applied to conditions of the head found in children at the time of birth, and infants thus affected are generally hydrocephalic. The words indicate a protrusion, a hernia, through the skull, either of the membranes of the brain or of the brain itself, the protrusion appearing as an elastic tumor in the line of one of the sutures. Such cases are always associated with some deficiency of the bones of the skull—it may be of some portion of the frontal bone, near the root of the nose (Fig. 83) or near its external angular process, and by far the most frequently of the occipital bone. In rare examples

the deficiency may be at the base of the skull. Dr. Lichtenberg has recorded a case in the *Transactions of the Pathological Society*, vol. xviii., in which the tumor was hanging out of the child's mouth and communicating with the skull through an opening in front of the sella turcica.

Varieties.—In a *meningocele* the membranes may protrude as a whole, but sometimes the dura mater alone projects (*vide* Prep. 1563[30], Guy's Museum). In the true *encephalocele* the brain itself is pressed out of the skull into the external tumor. This was well seen in a patient from whom the accompanying drawing (Fig. 84) was taken; the skull contained the anterior and part of the middle lobes of the brain, and the sac the remaining portions.

Fig. 83.

Meningocele at Root of Nose.
(Mr. Poland's case.)

Fig. 84.

Meningocele.
(Drawing 501[30], Guy's Hosp. Mus.)

The ventricles were likewise divided between the two. The posterior lobes were adherent to the membranes that formed the sac. In a *hydrencephalocele*, in addition to the brain substance, there will be a portion of one or both of the ventricles filled with fluid.

"An *encephalocele*," writes Sir P. Hewett (*St. George's Hosp. Rep.*, vol. vi.), "is of a round or oval shape; in size it seldom exceeds that of a small orange: its attachment is broad; the integuments covering it present little or no alteration. In the earlier periods it has the characteristics of a watery bag, but later on, as the fluid gradually disappears, the brain matter fills the sac, and then the tumor becomes soft and doughy."

A *hydrencephalocele* "in shape is more or less pyriform, with a marked contraction at its attachment, and sometimes a long and narrow stem; in size it is apt to become much larger than an encephalocele. The integuments over it are thinner; fluctuation exists about the hernia, and large veins may be traced under the skin."

When these tumors are small and have a very minute communication with the cranial contents, they have been, and may be again, mistaken for some simple cyst or tumor. The surgeon should therefore always suspect that a cystic tumor situated over a fontanelle or suture, and particularly when over the nose, may have some communication with the membranes, and he should consequently postpone all operative interference till the diagnosis is clear. As the bones ossify the opening between the tumor and the cranial contents may close. The cyst, if small, may then be excised; if large, it may be injected with iodine or Morton's iodo-glycerine solution. The utmost caution, however, must be employed in the treatment of these cases, and where uncertainty exists as to their true nature or attachments the prudent surgeon had better leave the case to nature than risk life by any hazardous enterprise.

Serous cysts simulating encephaloceles are met with. Billroth (*Clin. Surg.*, p. 43) and Atlee (*American Journ. of Med. Science*, January, 1883) have each recorded an example. Both were congenital and on the back of the head, with serous contents. In Billroth's case, when the child died, the cyst was found to consist of a thin wall with a very smooth lining. It lay in the cellular tissue beneath the scalp and was entirely removable from the bone. Atlee's case was tapped, and two ounces of serous, not cerebro-spinal, fluid were drawn off with success, and the sac subsequently withered.

Ostitis and periostitis of the bones of the cranium are common affections, and may occur either as a consequence of a local injury, of syphilis, of ostitis, or of other causes. They are also often associated with brain complications. Under the heading of "Traumatic Encephalitis" this subject was discussed, together with its treatment, and ostitis coming on from any cause other than injury presents very similar symptoms. I have seen in an infant periostitis the result of hereditary syphilis, and ostitis

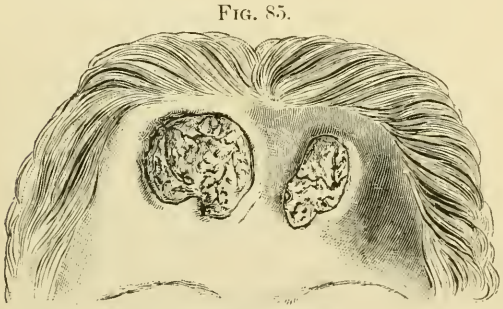
ending in necrosis. I have seen also half the frontal bone of a babe exfoliate after a punctured wound from a nail without any brain symptoms. In the adult the complications attending inflammation of the bones, syphilitic or otherwise, are very variable.

Symptoms.—The symptoms are generally local so long as the inflammation is confined to the periosteum covering in the bone, the chief being pain and tenderness with local swelling, though when the inflammation has spread to the inner periosteum or dura mater other symptoms appear, such as constant headache and great irritability of brain; any worry or work increases pain, causes fever, restlessness, and want of sleep. As the disease progresses delirium, convulsions, paralysis, coma, and death may be the result.

The inflammation in the bone may go on to suppuration or necrosis, and the dead bone may exfoliate in masses (Fig. 85) or in small portions. Should no external outlet for the pus form or be made, either by natural processes or by the surgeon, the retained pus within the skull may give rise to symptoms of compression of the brain, when it is probable that the brain itself and its serous membrane will become involved and the case assume a most serious aspect. It is, consequently, a point of great importance for the surgeon to anticipate such a complication, and, if possible, to prevent it.

Treatment.—When a patient has had a blow upon the head and been either the subject of syphilis or of chronic suppuration of the ear, and as an after symptom has a local swelling associated with pain of a constant and wearying character, the presence of a local ostitis should be suspected. When the swelling is tender to the touch and pain is aggravated by local pressure, this suspicion should be strengthened; and when these conditions are attended by pyrexia more or less severe, by sleeplessness, a quick irritable pulse, and a contracted pupil, inflammation of the bone, probably implicating the dura mater within and the periosteum without, may safely be diagnosed. Under these circumstances a free incision down to the bone should be made, since experience has proved that by the adoption of this practice pain and other symptoms are, as a rule, relieved, and serious brain complications are often prevented. When external suppuration is present and dead or dying bone is exposed, it is less common to meet with cerebral symptoms, since the pus finds its way externally through the wound, and there is consequently less irritation of and pressure on the dura mater, as well as less brain irritation. Should, however, brain complications appear, it is important to prevent their spreading for the surgeon to interfere, as, when confirmed brain symptoms have manifested themselves, the case is almost hopeless. The surgeon, under these circumstances, should attempt to remove the necrosed bone or perforate it by the trephine, both these operations having one common object—viz., to give free vent to the pus beneath the bone. Indeed, trephining, under such circumstances, is not only a justifiable but a valuable operation, and if performed with care can do little harm. When operation is postponed till confirmed brain symptoms have appeared, there is too much reason to believe that irremediable changes have taken place, such as suppuration within the hemisphere or arachnitis, which no operation is likely to relieve; and yet "trephining" has been of use even in such cases when complicated with epileptiform convulsions. The surgeon, however, should anticipate this stage of the disease when he can and interfere before such symptoms appear, headache of a local and persistent character associated with evident signs of local ostitis or necrosis being always an indication of the propriety of trephining.

Fig. 85.



Necrosis of Frontal Bone. (From Emily S——, æt. 19, June, 1870.)

I need hardly add that constitutional treatment such as has been mentioned under the heading of "Encephalitis," and will be alluded to when the subject of syphilis is considered, ought to be carefully followed out.

M. Aran, *Archives Générales de Médecine*, 1844.—Cock, *Guy's Hosp. Reports*, 1842.—Hewett, *System of Surgery*, by Holmes, 3d ed., 1883.—Le Gros Clark, *Lectures at Royal College of Surgeons*, 1869.—Pott, *Injuries of the Head*, 1768.—Guthrie, *Commentaries on Surgery*, 1853.—Erichsen's *Surgery*, 5th ed., 1869.—Hutchinson's Prize Essay (Astley Cooper), 1865.—Brodie, *Med.-Chir. Trans.*, vol. xiv.—Wilks and Moxon's *Lectures on Pathology*.—Callender, *St. Bartholomew's Hosp.*

Reports, vols. i. and iii.—Hilton, "Clinical Lectures," *Lancet*, 1853.—Nélaton, Atlee's edition, 1855.—Gama, *Traités des Plaies de Tête*, 1835.—Adams, *Cooper's Surg. Dictionary*, 1861.—J. Neudorfer, M.D., Prague, *Handbuch der Kriegschirurgie*, 1867.—Pirogoff, N. Leipzig, 1864.—Stromeyer's edition of W. MacCormac's *Notes of an Ambulance Surgeon*, 1871.—West, *Med.-Chir. Trans.*, 1880, vol. lxiii.

ON TRISMUS AND TETANUS.

When a patient is the subject of an uncontrollable spasmodic contraction of the muscles of the lower jaw, he is said to have "*trismus*," or lock-jaw; and when the same condition attacks other or all the voluntary muscles of the body, he is said to have "*tetanus*." Tetanus includes trismus, and generally begins with it, though trismus may be a local affection. It is found in children as a result of dentition, and in adults as a consequence of diseases involving the teeth, gums, or jaws. It is a spasmodic affection produced by reflected irritation set up by a local disease, is rarely associated with any constitutional disturbance, and is, for the most part, cured on the removal of its cause.

Varieties.—Tetanus is likewise generally associated with some local source of irritation, some wound or injury, and is then called "*traumatic*." When no external or visible cause can be made out, it is denominated "*idiopathic*." When rapid in its course, it is called "*acute*;" when slow, "*chronic*." The acute form is usually the result of an accident, and generally fatal. The chronic is for the most part idiopathic and more curable.

Infantile Tetanus.—Tetanus is met with in new-born infants, and is then known as *trismus nascentium* or *tetanus infantum*. It usually comes on the second week after birth, and may be so acute in its course as to destroy life in from ten to thirty hours, or life may be prolonged to eight or nine days. It is a common affection in the West Indies, and has been known to occur frequently in ill-ventilated lying-in hospitals. Bad ventilation, consequently, has been put down as one of its causes, the others being cold, exposure, internal irritation, and the division of the umbilical cord.

Predisposing Causes of Tetanus.—Dismissing the last form of the disease from our consideration, it seems that tetanus may be found at any period of life, though more than half the cases occur between ten and thirty years of age. The youngest case on record was in a child of twenty-two months, and the oldest in an adult of seventy-five years.

It is more than seven times as common in males as in females, and it is found in the healthy as frequently as in the cachectic; nor do the intemperate seem more prone to its attack than the temperate. It is, too, as frequent in the winter as in the summer months, though in warm climates the natives are more susceptible to its attacks than Europeans. Exposure to damp, cold, or sudden changes of temperature have doubtless a powerful influence in exciting this disease, in both the idiopathic and traumatic forms. Larrey records that after a great battle a hundred soldiers were found affected by it in one morning.

Exciting Causes.—Tetanus is rare in the course of ordinary surgical disease, although it may follow any form of injury, from the slightest contusion to the severest compound fracture. It may occur after the extraction of a tooth or the gravest operation in surgery, and it is known in obstetric practice as *puerperal* tetanus. It is most common after the more severe varieties of accidents, such as burns, compound fractures, and injuries to the fingers and toes, though there is no evidence to prove that it is more frequent after slight injuries to the fingers and toes than to other parts. Lacerated seem to be more frequently followed by tetanus than incised wounds, particularly in children; but the state of the wound does not appear to have any influence on the disease. Seven years' experience at Guy's Hospital gives the following facts (Poland):

Tetanus occurred in	1	case out of	1394	cases of major and minor operations.	
"	"	9 cases	"	594	" of wounds of all varieties.
"	"	1 case	"	856	" of injuries and contusions.
"	"	3 cases	"	456	" of burns and scalds.
"	"	9 "	"	398	" of compound fractures.
		23		3698	" or 1 in every 160 cases.

Date of Appearance.—There is no definite period at which tetanic symptoms are prone to appear. When they set in soon after the injury, they are for the most part acute and very fatal; after the lapse of three weeks, the chances of their appearance are very small. Acute cases, however, occasionally occur during the second week; upon this point Poland gives us the following facts:

Of 277 cases, 130 began before the tenth day, and of these 101 died.
" " 126 " between the tenth and twenty-second days, and of these 65 died.
" " 21 " after the twenty-second day, and of these 8 died.

In tetanus following exposure to cold the symptoms generally appear rapidly after the exciting cause, and with the same exciting cause similar results occur in the traumatic form.

Symptoms.—There are no general or local premonitory symptoms by which the onset of this affection can be recognized, and the earliest indications of its approach are generally a difficulty in opening the mouth and stiffness in the muscles of the lower jaw; yet these symptoms may be so slight as to pass unheeded or be misinterpreted. When, however, some rigidity of the muscles of the neck, throat, or abdomen can be made out and the first indications of the "tetanic grin," or *risus sardonicus*—which is caused by the drawing down of the corners of the mouth by the muscles of the face—are recognized, the diagnosis becomes certain. Difficulty in swallowing will then soon appear (any attempt to drink fluids exciting spasm of the muscles of deglutition, and often of respiration), with pain, due to spasm of the diaphragm, shooting through the body from the scrobiculus cordis.

As the disease progresses the muscular system of the body generally will be more or less affected, and in different cases different groups of muscles will be involved. Those of the back are the most frequently attacked, and their contraction may be so powerful as to cause an arching backward of the frame, producing what is known as "*opisthotonos*." In rare cases the body is bent laterally or forward, the terms "*pleurosthotonos*" and "*emprosthotonos*" being respectively applied to such conditions.

The muscles of respiration are, as a rule, affected in acute cases, and the chief danger to life consists in the severity of the spasms which attack them. When severe, the first spasm may be fatal and may occur at an early or at a remote period of the affection. In a case under my care of severe traumatic tetanus all the symptoms were disappearing and recovery was confidently expected, when, on the tenth day of the disease, the first spasm of the laryngeal muscles took place, which destroyed life.

When the jaw is unlocked by a spasm of the depressor muscles, the tongue is sometimes suddenly shot out from between the teeth, and often wounded.

Progress of Disease.—As the disease advances the jaws become completely fixed, and deglutition is then impossible. The spasms of the muscles of the frame become more intense and frequent and the powers of the patient rapidly decline. The pulse, which was rapid, becomes more feeble, while the expression of the countenance betokens agony of the body and despair of mind. The slightest manipulation or movement of the patient sets up a fresh spasm, and any emotion may do the same. The skin becomes bathed with a cold sweat; and if death is not caused by suffocation, exhaustion soon puts an end to suffering.

There is rarely any fever during the whole course of the disease; the bowels are always costive, the stools offensive, and the urine, as a rule, natural.

The intellectual faculties of the patient almost always remain unimpaired throughout, while the senses are morbidly acute. Anything like delirium is rarely seen.

Should the case tend toward recovery, the spasms will become milder in character and recur at longer intervals till they disappear. *It should be remembered, however, that as long as the slightest evidence of disease exists a sudden spasm of the glottis may at any time destroy life.*

Diagnosis.—This should not be a difficult task, and in every instance of lock-jaw the possibility of its being the commencement of tetanus ought to be entertained. Local irritations, however, may produce a locking of the jaw more or less complete; but such are never accompanied by uncontrollable spasm, as is the case in tetanus.

To diagnose between tetanus and poisoning by strychnine may be difficult, the symptoms of both being very similar; yet in tetanus the symptoms are progressive, while in poisoning they appear suddenly in all their severity. In tetanus muscular rigidity is always present, and aggravated at intervals; in poisoning there are complete intervals of relaxation of muscle. In tetanus, too, there is constant rigidity of the muscles of the jaw; in poisoning, the jaw is never locked except during the spasm. These points of difference are sufficient to assist the surgeon in the investigation of a doubtful case.

Again, hydrophobia and tetanus have been mistaken the one for the other; but any one who has seen the former disease could hardly fall into such an error. The peculiar restlessness of mind and body, the complete intervals of rest and absence of spasm, the peculiar aversion that is shown to fluid, accompanied by thirst—all symptoms character-

istic of hydrophobia—are enough to distinguish between the two. Nevertheless, it should be remembered that Dr. J. W. Ogle, late of St. George's, has recorded a case of tetanus and hydrophobia combined.[1]

Prognosis.—In acute traumatic cases there are small hopes of recovery, while in chronic the chances are greater. The longer the patient lives, the better seem the prospects of a good result; and if ten days pass after the first appearance of the symptoms and the disease is on the decline, the prognosis is favorable.

Taking all cases together, Poland gives one recovery to seven and a half deaths. More than half die within five days. The most rapid death has been in from four to five hours, and the longest duration of life on record in a fatal case is thirty-nine days.

How Death is Caused.—There can be little doubt that acute tetanus commonly destroys life by apnœa, spasm of the muscles of respiration, and more particularly those of the larynx, being the immediate cause. Poland tells us that this was the case in thirty-two out of forty-six cases at Guy's Hospital in which the mode of death was noticed.

In chronic tetanus death is commonly caused by exhaustion. These facts have an important bearing on the treatment of the disease.

Pathology.—The late Mr. William King of Guy's is stated by Poland to have been in the habit of remarking at the post-mortem table whenever there was an examination of a case of death from tetanus, "Gentlemen, we will now proceed to give you a demonstration of a case of healthy anatomy, for there will be no visible morbid appearances otherwise than congestion of the organs in various degrees, owing to accidental circumstances." And at the present day these remarks hold good. It is true that Rokitansky, Demme, Lockhart Clarke, and Dickinson have given us some descriptions of structural changes in the spinal cord which they have observed, and their observations, moreover, seem to coincide. These changes consist of disintegration and softening of a portion of the gray substance of the cord, which appears in certain parts to be almost diffluent. The semi-fluid substance thus formed, however, "is at first more or less granular, holding in suspension the fragments and particles of the disintegrated tissue, but in many places it is perfectly pellucid." Yet it is to be remembered that Billroth and other pathologists have failed to find these changes in the instances which they have examined, and it cannot, therefore, be accepted as certain that these pathological conditions are constant in tetanus. There can be little doubt, however, that the nerves of the injured part are at times found inflamed and irritated, and from this fact the theory has been advanced that through the injured nerves of the part the spinal centres become involved, and manifest these states of excitement through the motor nerves by producing muscular spasm, the disease being one essentially of the excito-motory system. Clarke believes "that the spasms of tetanus depend on the conjoined operation of two separate causes: First, that they depend on an abnormally excitable state of the gray nerve tissue of the cord induced by the hyperæmic and morbid state of its blood vessels, with the exudations and disintegrations resulting therefrom; second, that the spasms depend on the persistent irritation of the peripheral nerves, by which the exalted excitability of the cord is aroused."

Treatment.—Every imaginable form of treatment has been employed in this disease with success, to be discarded in its turn for something new. No settled form of practice can consequently be laid down. Still, much can be done in guiding the patient through this disease, in keeping him alive, and in warding off death.

To keep the patient alive the most careful attention to feeding is required, milk and concentrated liquid animal food being the best diet. If these can be taken in sufficient quantities, no other mode of administration is required; but if not, they must be given as enemata every four or six hours, as the case demands. Stimulants must be used cautiously, though when the powers are failing they may be freely given.

Upon this principle of practice quinine has been strongly recommended; it may be given in full doses to an adult, such as five grains every three or four hours, and then increased, or in one large dose, such as twenty grains, to be followed by the smaller one.

Among specific remedies that have been greatly vaunted, the Calabar bean stands foremost, and may be trusted; it should be given in full doses, such as half a grain of the extract every two or three hours, or one-twenty-eighth of a grain of its essential principle, eserine, increased to double, even the tenth of a grain. Camphor also recommends itself to our notice in doses of from five to ten grains. The woorara poison has failed in its purpose. The bromide of ammonium or potassium has, however, been administered with advantage.

[1] *Brit. and For. Med. Review*, 1868.

It was hoped that a valuable drug for this disease had been found in chloroform, but experience has not justified the expectation. The hydrate of chloral has now taken its place and been of some service. Demme has advocated with much success the use of the curara, eight cases out of twenty-two having recovered under such treatment. In India the Indian hemp has been highly recommended. Nicotine and tobacco have also been successful. Aconite is another drug that offers some advantages, while opium has an unquestionable influence in allaying pain and mitigating the severity of the spasm. Ice, also, applied in bags along the spine, has apparently been of great value in the hands of American surgeons. The administration of remedies by subcutaneous injection in these cases promises to be a valuable adjunct to practice, enabling us rapidly to introduce into the system drugs that act antagonistically to tetanic spasm.

The patient should always be kept quiet, warm, and free from draught. He should, moreover, be so watched that in his spasms no injury can be sustained; attention should be paid to his bladder and bowels, for catheterism is sometimes called for; and purgatives and enemata to clear out the intestines are beneficial, although violent purgation cannot be advised.

Question of Amputation.—With respect to *local treatment*, much may sometimes be done. In severe local injury when the nerves of the part are probably involved amputation ought certainly to be performed, for a sufficient number of cases have been recorded in which success has followed the practice. In 1845, Mr. Key amputated a leg on account of tetanus which had appeared six days after an unreduced dislocation of the astragalus; the symptoms disappeared at once after the operation. On dissecting the foot the posterior tibial nerve was found to have been put violently on the stretch by the projecting astragalus.

In some cases soothing applications, such as opium, may be applied to the wound, and in all perfect cleanliness should be enforced.

One other means of cure remains to be noticed which has reference to the mode of death in this disease. It has been shown that in the larger proportion of cases—in all the acute—death is caused by suffocation from spasm of the laryngeal muscles. It is also fairly recognized that this disease runs its course, and that the most our science can accomplish is to maintain life and ward off death. To this end the operation of tracheotomy seems to be of value, for with a tube in the trachea death by laryngeal spasm cannot take place, and a better prospect of recovery is consequently given.

I have employed this practice in one acute case, in which the Calabar bean was likewise given, and the patient sank from exhaustion, free from spasm; and there seems good reason to believe that if I had performed the operation in the case I recorded in the early part of this chapter life would have been saved. This matter, however, requires grave consideration, and the practice is not to be rashly followed.

Morgan, *On Tetanus*, 1833.—Curling, *On Tetanus*.—Poland, *Guy's Hospital Reports*, 1857.—Dr. Ogle, *Brit. and For. Med. Review*, 1868.—Dr. Dickson, *Med. Chir. Trans.*, vol. vii.—Dr. L. Clarke, *ibid.*, vol. xlviii.—Dr. Dickinson, *ibid.*, vol. li.—Demme, *Schmidt's Jahrb.*, vol. 112.—Thamhayn, O., *ibid.*—*Year-Book*, Sydenham Society, 1862–64, etc.—"Puerperal Tetanus," *Dublin Quart. Jour.*, 1865; *Med. Times and Gaz.*, 1865.—Billroth, *Pathol. Chirurg.*, 1868.

DELIRIUM TREMENS.

It often falls to the surgeon to treat cases of pure delirium tremens uncomplicated with any surgical malady, and it is well, therefore, to refer to this subject by itself. There are other cases, perhaps, more aptly described by the term "*traumatic delirium*," in which the nervous symptoms are developed as a consequence of an injury received. In both classes the symptoms are essentially the same and the treatment required is similar; still, it is right to bear in mind the difference in causation, as in the one we have to deal with a nervous disease in an intemperate person, and in the other with the same symptoms as an incident in a surgical case. In simple delirium tremens, to use the familiar term, we have to deal with the case of a person who has indulged for an uncertain time in injurious doses of alcoholic liquors. It may be that a young man after a prolonged debauch has an attack of the "horrors," but the symptoms more frequently occur in those who have for a long period accustomed themselves to the excessive use of beer or spirits, even without amounting to drunkenness, and who at length are subjected to some shock or depressing influence. Inasmuch as the habits which have been mentioned as superinducing this disease are opposed to the simplest laws of health, it follows that they cannot be indulged in with impunity for long, and consequently we find

the subjects of it, as a rule, of feeble powers of resistance and often with diseased viscera. Such persons are bad subjects for any ailment, and it often happens that when a person of this sort breaks his leg or meets with some injury requiring surgical treatment he becomes the subject of delirium tremens. Other causes are occasionally at work, such as starvation, mental anxiety, and the overuse of tobacco or opium.

The disease is at times ushered in by certain premonitory symptoms, as patients who have once been the subject of an attack are sometimes conscious of the approach of another. A brewer who had been treated for this affection at Guy's some years ago, when he felt warnings of its advance on several occasions applied for admission, and as a result the attack was warded off.

Depression of mind and depression of body are the chief premonitory symptoms, with restlessness and agitation, gloom, and foreboding of evil. Some slight febrile disturbance may also exist, but the one invariable and most important symptom is sleeplessness. The tongue is generally pale and flabby, as well as coated with a whitish fur, and is never dry. The appetite is bad, the breath often fetid, and the bowels confined. The pulse may be quick, though soft and powerless. The skin is always moist, and at times bathed in perspiration. With these symptoms the characteristic delirium with trembling is not far off. It may, however, in surgical practice set in suddenly without warning. The nature of the delirium is very characteristic and is always accompanied by allusions which are generally spectral. The patients see objects that do not exist and hear sounds that are imaginary, these being always of a strange or frightful nature. At times some delusion as to business or home matters agitates the mind. These same unsound ideas are sometimes fixed during the whole attack, but more commonly succeed one another in rapid rotation. Sleeplessness, under these circumstances, is a constant accompaniment. The patient will be quiet for a time, muttering words without meaning, or he will be restless and get out of bed in obedience to some imaginary call. He will pull about his bedclothes, will rise up in bed at one moment under one impression and lie down again under another. If asked to put out his tongue, he will do so, but probably with a jerk ; if to give his hand, he will project it with a thrust. A nervous trembling of the extremities, with an utter want of control or steadiness of purpose, is characteristic. If these symptoms continue and rest cannot be obtained, prostration of all the powers will rapidly appear and death will supervene from exhaustion or coma. If sleep—sound sleep—can be secured, the symptoms usually mitigate rapidly.

The PROGNOSIS must depend on several considerations. If the patient be young and the attack ensue after a short period of drinking, the chances of recovery are hopeful ; but if the attack occur in a man of middle age habituated to overdrinking, and if his liver or kidneys be unsound, it is fraught with much greater danger. If the attack be associated, moreover, with an injury such as a wound or fracture, another element of danger is introduced. The best guide to the patient's real condition is the study of the pulse—not merely as to the number of its beats, but with regard to its character. The sphygmograph is of great service in such cases, as by its help a "dicrotic" state of pulse is often shown where the finger would not indicate it ; and such a condition is a bad omen. The most frequent complication is pneumonia, which often comes on rapidly and insidiously and is a frequent cause of speedy death even when the excitement has subsided.

TREATMENT.—This disease essentially being one of depression of the nervous system associated with sleeplessness, the main object of the surgeon is to induce sleep, to calm the excited brain, and to give it time to recover its normal functions ; and with this end absolute quiet and the use of bland and nutritious food are most essential.

Easily-digested nutritious food must be administered when it can be taken by the mouth ; but when refused or rejected, resort must be had to enemata. Milk is undoubtedly the most suitable form of nourishment, either alone or mixed with eggs ; but it does not suit all stomachs. The question of giving stimulants, and to what extent, is one of great importance. As a rule, the less given the better, but in some cases it is advisable to give them ; and that form of alcohol to which the patient has been accustomed is the best. Young men with an acute attack may do well without any, but in other cases the feeble powers of the patient require some such aid to stand against the exhaustion caused by the restlessness and excitement. The chief reliance, however, should be placed on other forms of food, such as strong animal broths, Darby's fluid meat, or similar preparations.

Opium in one of its forms is a drug still in favor, although some reject its use altogether and trust to feeding and time, relying upon the knowledge that the disease has a natural tendency to terminate in sleep after the second or third day. In an ordinary case of the disease one grain may be given as a dose, or ℥xx of the tincture, repeated every

three or four hours or oftener, till sleep is procured. In other cases two or three grains may be given at once and followed by grain or half-grain doses.

The best method of administering drugs in this disease, however, is by subcutaneous injection; and I recommend the injection of morphia in solution in doses of a quarter or half a grain in preference to any other plan, because the condition of the stomach of patients suffering from the disease is far from satisfactory either for absorption or assimilation, and by the hypodermic method of introducing the narcotic into the system its absorption is more certain and rapid. In some cases the beneficial influence of morphia thus employed is very remarkable, and only in exceptional instances the treatment fails.

The use of chloroform has also been urged, though such a plan is not devoid of danger and can hardly be advised except for some temporary purpose, such as to dress a wound or to enable an enema to be given. The hydrate of chloral is a drug of great value as possessing hypnotic qualities without the evils attendant on other drugs of this class. It may be given in doses of twenty or forty grains, and repeated at moderate intervals till sleep is procured; when combined with ten-grain doses of the bromide of potassium, it seems to be of more use. Drs. Kinnear and Lawson in the Melville Hospital have treated from seventy to eighty cases successfully with large doses of cayenne pepper, from twenty to eighty grains having been given as a dose. Dr. Maclean of Netley trusts to quiet and the use at short intervals of strong beef tea highly charged with cayenne pepper.

Of late years the value of digitalis has been greatly extolled, but my experience of it has not been favorable. It is given in large, if not poisonous, doses, such as two drachms of the tincture every hour for three or four doses till sleep is produced. It is a dangerous mode of treatment, and cannot be recommended.

When great excitement and some fever exist, antimony in small doses has been much advocated. The condition of the bowels almost always demands attention, as the tongue is usually foul and the secretions morbid. A purge sufficient to empty the colon is consequently of service, but violent purgation is injurious.

Tonics, such as quinine and iron, with or without opium, will be required as the disease subsides. The combination of the tincture of iron with the tincture of opium in carefully regulated doses is preferable. In other cases ammonia with bark may be administered.

Question of Restraint.—With respect to coercive measures in the treatment of these cases, there is no doubt that they ought to be condemned. In exceptional instances, where sufficient help cannot be obtained to prevent the patient from injuring himself or others, the jacket doubtless must be employed, but under no other circumstances is it justifiable. An attendant who combines decision of character and firmness with a gentle and soothing manner will almost always succeed in "influencing" the most troublesome patient. He is to *influence* him, however, and not to direct him; for contradiction and the exercise of authority over the subjects of this disease invariably excite opposition.

Chronic Intemperance.—There are some people who are never drunk, yet are always drinking—in whom the tissues are so weak that under injury they rapidly break up and under disease show no power of repair. In such it is difficult to induce wounds to heal or show any vigorous action.

The best remedy is to supply such patients with all sorts of nutritious food, to give tonics and a moderate amount of stimulants, and thus endeavor to improve their habits as well as restore them to a more healthy tone.

SHOCK AND COLLAPSE.

Shock.—A man receiving unexpectedly some startling news which excites severe emotion, and dying suddenly, is said to die from shock; a second receives a fatal blow upon the epigastrium; a third is struck dead by lightning: death in each case is said to be due to shock. In all the heart's action is suddenly arrested through the nerve centre —in one case through the mind, and in the others through the body. Under these circumstances the heart is found full of blood, distension having paralyzed its action.

Collapse.—A man receives a severe compound fracture, gunshot or other injury, and is not killed, but collapsed. Another, or possibly a child, is much burned or has a large portion of the integuments of a limb torn away or crushed, in which the peripheral nerves are seriously involved, and as a result reflex paralysis of the heart occurs. Both have sustained a shock more or less intense, and as a consequence become cold and almost, if not quite, pulseless. In either case the skin appears to be bloodless and cov-

ered with a cold clammy sweat. He may breathe almost imperceptibly, feebly, or with sighs and gasps. His nostrils will probably be dilated, his eyes dull, his vision imperfect, and consciousness may be lost in very variable degrees; the patient may possibly be roused, yet, as a rule, he requires rousing to prove the existence of consciousness. At other times the intellect remains quite clear.

These are, briefly, the signs of collapse or shock the result of injury. They are to be found in variable degrees after most accidents, and are by no means usually fatal unless the injury itself is fatal. Of course, if the shock from the injury is very great, the heart may cease to beat and the lungs to breathe, collapse passing more or less slowly into death; but more usually, after a variable period, the heart's action gradually improves, the respiratory act becomes more regular, and perfect color returns to the bloodless lips and skin, warmth reappears on the surface of the body, and consciousness becomes more manifest. These symptoms indicate what is known as reaction; and when they are excessive, febrile symptoms may appear. It should be noted that vomiting is often the first indication of reaction in general collapse, as it is often in that of head injuries. Should the nature of the accident be such that hemorrhage complicates the case, the collapse will be more lasting, the shock of the accident passing into collapse from hemorrhage; under such circumstances a fatal result is very likely to ensue (the amount of bleeding and its rapidity determining the result), for it should be known that hemorrhage by itself is enough to produce collapse, or syncope, and this, added to the shock of the injury, is often more than enough to destroy life. In abdominal injuries this combination is well seen, the hemorrhage from a lacerated liver or other organ, as a rule, appearing with the first manifestations of reaction from the shock of the accident, and thereby proving fatal.

The longer the reaction is delayed, the more grave is the aspect of the case; not unfrequently relapses appear, signs of reaction and of collapse alternating in variable degree, till one or the other asserts itself in recovery or in death.

In rare cases, even from the shock of a slight accident, reaction is followed by exceptional symptoms; thus I had a man under care who was admitted with a slight concussion of the brain, in whom reaction was attended with an acute attack of maniacal excitement which left him after two days to pass on to a steady convalescence. A woman with a similar injury attended with a scalp wound had a like attack, which lasted a fortnight and then subsided without any bad results. I have recorded also in another page a case of general tetanic spasm which showed itself in the reaction after a case of spinal injury. More commonly, however, reaction is attended with what Travers has described as "prostration with excitement"—a state bordering on and often passing into that known as delirium tremens.

Under some conditions of the system shock and collapse are more readily produced than at others; thus very young and very old subjects, those enfeebled from age or other cause, mental or physical, are particularly apt to die of shock after injury or operation. When bones are involved in the injury and symptoms of "shock" appear after a day or two's satisfactory progress, Professor Nussbaum believes them to be due to fat embolism as evidenced by severe dyspnœa, œdema of lungs, and sudden death. Patients with bad kidneys, also, are very liable to suffer from shock and to succumb to any operation, however trivial. Surgeons see this at times in the sinking after small operations. Thus I lost some years ago, after the removal of a fatty tumor, a woman of middle age, simply from asthenia, the operation having been unattended by any loss of blood; also a child æt. 8 after some operation on a cicatrix of the neck in the same way. In both, bad kidneys were found after death. The idiosyncrasy of the individual has also a powerful influence on "shock."

TREATMENT.—Shock or collapse uncomplicated with hemorrhage may be treated in one way, shock or collapse the consequence of or combined with hemorrhage in another.

In both cases the heart's action must be either excited or maintained; "the heart must beat and the patient must breathe," or life will fail. Even in the worst cases, as long as any signs of life exist, the respiratory process may be aided by artificial respiration and the warmth of the body kept up by external applications. Savory in an able article (*Holmes's System*, ed. 2, vol. i.) advises as the result of experiment and reasoning that, should no evidence of the heart's action be detected and no hemorrhage complicate the case, a vein should be opened—as the external jugular—in order that the overdistended heart may resume its action as soon as it is relieved from its paralysis by distension.

In the extreme collapse following hemorrhage transfusion is also "a fair and rational expedient."

In less severe examples the surgeon's object should be to keep the patient alive, but he ought not to try to do more, as to force nature is always injurious, and sometimes fatal. The failing powers of a feeble subject may be excited to act only to give way again; they may not a second time respond to the former stimulant.

A too rapid reaction may so stimulate the heart as to set up a fatal hemorrhage, when by the collapse the wounded artery might have become sealed by nature's own blood-clot.

In all cases of shock and collapse, therefore, complicated with local injury, great judgment is called for. To do enough to maintain life is essential, but to do more is injurious.

The horizontal position under all circumstances should be observed, and external warmth secured by means of blankets and hot flannels applied to the pit of the stomach. Sir J. Simpson's plan of applying heat to the body is very beneficial—by filling six or eight soda-water bottles with boiling water and tightly corking them, and then drawing over each a woollen stocking wrung out of hot water. The bottles so covered are then to be packed around the patient in bed. Stimulants in carefully adjusted quantities may be given, and brandy is the best. This should be given in small quantities; and if the heart's action fail to respond to its administration after two ounces or so have been swallowed, more is of little service, the stomach usually rejecting it. When the stomach rejects brandy or the patient cannot swallow, an enema of brandy in warm starch, milk, or gruel sometimes acts very rapidly. As soon as the heart's action is established liquid food, such as warm milk, may be given, though only in small quantities, and the case should be carefully watched; food and stimulants should be given with discretion and as the symptoms indicate, the greater the loss of blood, the greater being the necessity for food.

Excess of reaction is to be checked by soothing remedies—opium in any of its forms, henbane, and chloral are also very valuable—a few hours' calm sleep generally acting like a charm; yet when brain complication appears, this treatment is to be adopted with care. Anything like coma contraindicates it.

Amputation in Collapse.—In compound fractures and other local injuries demanding operation the question of operating on a patient in a state of shock is important. Can the operation act as a stimulant and tend to rouse him? or may it act as a second shock and tend the other way?

When the shock is severe and the patient almost pulseless, it is doubtless the wiser plan to postpone all operative interference till the heart's action is re-established. To amputate a limb under extreme collapse is to destroy what chance of life exists or to do an unnecessary operation. To amputate when reaction has set in after the lapse of a few hours, when external warmth, stimulants, and tonics have had their influence, is likely to prove successful.

In less severe examples of collapse, however, the same practice does not seem to be necessary, especially when hemorrhage has been the partial cause and is still continuing, because the loss of very little extra blood by oozing forbids, when collapse is present, any hope of a good reaction being established; and under such circumstances no benefit can be acquired by delay, but only harm. The administration of an anæsthetic has, moreover, a stimulating influence upon the heart and nervous system which is often very valuable. I have frequently performed primary amputation upon subjects in a state of partial collapse after injury under these circumstances, and have never regretted it.

With a patient in a state of collapse no amputation should be performed when by delay no harm can accrue. When hemorrhage, however trivial, is going on or is likely to recur at any moment, the surgeon should interfere and remove the part when its removal is essential. When the collapse is associated with semi-consciousness, chloroform is not needed, the operation itself acting as a sufficient stimulant; but when the mind is clear as to what is going on, its use should not be withheld, because, although it is true its secondary effects are sometimes depressing and may be injurious, in a general way it has a beneficial influence and tends to prevent a second shock, both mentally and physically.

When Extreme Collapse Exists.—"How far," writes Savory, "the patient should be allowed to rally, and when he has reached that state which will enable him to bear the operation, are, of course, questions which cannot be answered in a general manner, but which must be decided by the surgeon in each case."

When the surgeon is in doubt about acting, he had better decide in favor of delay. When no doubt exists as to the wisdom of removing an injured part and by delay harm must or may probably ensue, he should act at once, even when the patient has not quite rallied from the shock of the injury. When, so far as the local injury is concerned, the

delay of a few days or hours is unimportant, all operative interference should be postponed.

In severe compound fractures, gunshot or otherwise, hemorrhage is almost sure to occur as soon as reaction appears, and the shock of the removal of a limb is not so much to be dreaded as the loss of blood.

"Wounds of the large arteries of the legs and arms from balls and shells always bleed more or less at the time of reception, and more freely as the shock to the nervous system passes off and reaction comes on. Even when this nervous shock is not sufficient to produce immediate death, the chances of ultimate recovery must frequently turn on the mere question of loss of blood."

In military practice primary amputation upon the field is now generally preferred to secondary, and in civil practice a like rule should generally be enforced.

SUMMARY.—To perform any capital operation on a patient in a condition of extreme collapse or shock is bad practice. To do so, however, when a minor degree exists and the pulse can be felt, when by delay other dangers, such as continued or renewed hemorrhage are to be expected, is sound and good surgery. To an unconscious or only slightly conscious patient an anæsthetic is not necessary. To the conscious it has often a beneficial action, and tends toward the encouragement of reaction.

FEIGNED AND HYSTERICAL OR MIMICKED DISEASE.

I have placed these two classes of cases together for purposes of convenience, and in this section, as they are essentially diseases of the nervous system. Both in a measure, and with different degrees of accuracy, simulate real or organic disease. In feigned disease the will of the patient is strong to deceive; it is bent to simulate the symptoms of an affection of which the individual knows something, though not all, and from this the full knowledge of the surgeon or physician is to override the imperfect knowledge of the impostor and expose him. In the hysterical the will of the patient is weak; functional derangement is allowed to assume the garb of organic disease; subjective symptoms are intensified—not, however, from motives of deception, but from a want of the controlling influence of health, more particularly of the nervous centres, a condition of hyperæsthesia commonly existing from some imperfect nutrition of the nervous centres. In exceptional cases anæsthesia is present, more particularly in the larynx.

Feigned disease is a voluntary deception from beginning to end and is unreal. Hysterical disease is an involuntary exaggeration of some functional derangement, "an unwilling imitation of organic disease," and real.

Feigned affections are met with chiefly in the intellectually weak or those of crafty character, and in a general point of view are attended with an exaggeration of symptoms far beyond those met with in real or organic disease; pain is said to be far more intense than is usually met with, and paralysis more complete; every symptom simulated is extreme; inconsistencies are present which are not reconcilable with the symptoms usually met with in the disease simulated. These inconsistencies and exaggerations should always excite suspicion in the mind of the practitioner, causing him to test quietly every symptom or group of symptoms and to doubt his diagnosis until he has proved its truth. To the *subjective* symptoms, or those complained of by the patient, these remarks are very applicable; but to the *objective*, or those palpable to the observer, they are so to a degree. The subjective symptoms are always exaggerated, the objective inconsistent, the former being too bad for truth, the latter inconsistent with experience. For example, the rigor of an ague may be simulated, while the hot and the sweating stage is impossible. Epileptic convulsions, catalepsy, or madness may undoubtedly be imitated, but in all these there will be, when present, some exaggeration or inconsistency not found in the real disease. Nerve pains may be felt, but they will not follow any anatomical nerve distribution. Paralysis can also be readily simulated, but it will probably be too complete; it will on testing, more particularly when done unexpectedly, be associated with a greater degree of sensibility in the skin than is usually present. When of long standing, it will not be attended with the usual wasting. Vomiting, coughing, or spitting of blood can be artificially produced, though under these circumstances the severity of the symptom will probably contrast strangely with the mildness of any others with which it may be attended.

In fact, in feigned diseases, on a careful investigation into the history of the case, the succession of symptoms, their progress, intensity, and duration, some element will be brought out which is irreconcilable with truth, some suspicion that deception is at

work will be excited, which, if worked out, must unmask the imposture and prevent error.

The subjects of *hysterical disease or of nervous mimicry* are mostly what are called nervous and emotional. They have commonly "a very unusual mental character: in the majority there is something notably good or bad, higher or lower, than the average —something outstanding or sunken." In this affection "every part of the body may become under provocation the seat of an apparent disease that in reality does not exist; it may, and often does, assume all the attributes of reality with an exactness of imitation which nothing short of careful and accurate diagnosis can distinguish from the real disease." In joint and spinal disease the truth of this is most frequently seen, Brodie having stated "that among the higher classes of society at least four-fifths of the female patients who are commonly supposed to labor under diseases of the joints labor under hysteria."

Diagnosis.—How, then, it may well be asked, is the hysterical affection to be made out from the real? How is the surgeon to avoid falling into the error of treating some functional derangement as organic disease?

In a general sense, it may with truth be laid down that in hysterical affection of a part local pain and sensitiveness on manipulation are always great and bear no relation to the amount of changes visible or to be detected in the part. The slightest touch excites pain, which probably a bold one fails to do; the pain, too, rarely, if ever, follows the anatomical course of any nerve or nerves, and the onset of the symptoms is generally more sudden and severe than that usually ushering in organic affections. Febrile disturbance or increase of temperature, moreover, rarely complicates the case, however severe the local symptoms may be, and the nervous "disturbance very rarely takes the form in which morbid nervous influence produces, not mimic, but real, organic changes." In fact, all the subjective symptoms are much more severe than the objective, the latter being either very slightly marked or non-existing. For example, a girl is suddenly seized with severe and lasting pain in the hip, knee, or other joint, aggravated by movement or the slightest touch, and yet no visible alteration in its outline or structure can be detected, even after the lapse of many months. Another is as suddenly affected with spinal affection, as indicated by local pain in the back, inability to stand, etc., without any local evidence of organic disease. A third suddenly finds herself unable to flex or extend a limb, and the slightest force excites severe muscular spasm and pain. A fourth is attacked without a cause with some muscular spasm, possibly involving a finger or fingers—a spasm that resists all attempts at extension. A fifth suddenly loses sensation or the power of motion in some part of a limb, quite irrespective of nerve supply. In these cases, again, however severe the pain may be during the day, it is rarely felt at night. Such patients, as a rule, sleep well and quietly. During sleep, also, it often happens that joints which are immovable by day are found to be more flexed or more extended. Patients with supposed diseased spine are found on their sides coiled up in a natural attitude. As an aid to diagnosis, the value of some anæsthetic cannot be too highly praised, as with a patient under its influence rigid parts rapidly yield and rigidity of muscle returns only with consciousness; parts supposed to be paralyzed often move, and suspected joint disease disappears by a close examination where previously doubt existed.

Hysterical disease is more commonly met with in female than in male subjects, in the single than in the married, in those whose nervous systems have been unstrung from some mental or physical trial, or where the emotional centres are inadequately balanced by the higher controlling ganglia. It is characterized by the suddenness of its attack and the severity of all its subjective symptoms, neither the clinical history of the case nor the objective symptoms present being consistent with those usually met with in organic disease; the exaggeration of certain symptoms and the absence of others, coupled with the anomalies of its nature, mark the hysterical affection over the organic, and are sufficient to excite a doubt as to the true nature of the affection.

For valuable information on this subject, the reader may be referred to the lectures of Brodie, Skey, and Paget, Russell Reynolds's essay on hysteria, and Anstie's lectures in *Lancet*.

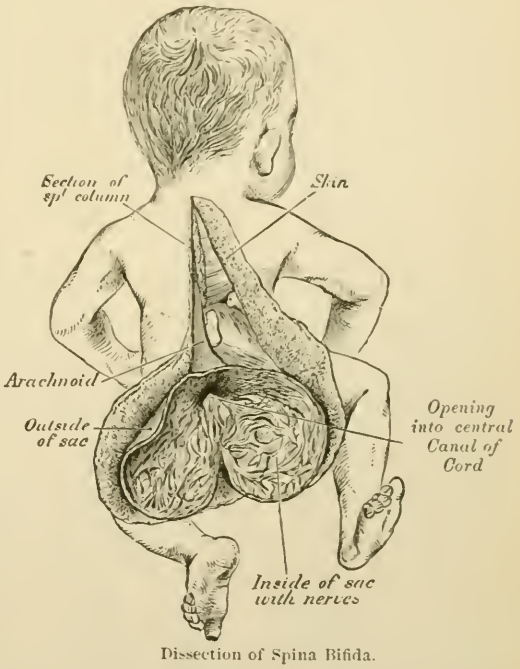
CHAPTER VII.

INJURIES AND DISEASES OF THE SPINE, ETC.

Spina Bifida.

A spina bifida is essentially a congenital hernia of the membranes of the cord through an opening in the spine, due to deficiency, from arrest of development, of the neural arches of some of the bones forming the spinal column. It is analogous to the meningoceles of the cranium, which have been already described. It always contains subarachnoid fluid, and often the spinal cord itself or large nerve trunks. Sir P. Hewett believes that when the fluid has collected in the subarachnoid space or between the cord and the membranes the cord is pressed, and that when fluid alone is present the collection is situated in the cavity of the arachnoid. In the specimen figured (Fig. 86), taken from a dissection kindly made for me by Dr. Pye-Smith, there was a funnel-shaped opening leading from the tumor into the persistent central canal of the cord, the nerves being spread out under the internal lining of the sac, and thus forming one of the layers of its wall.

Fig. 86.



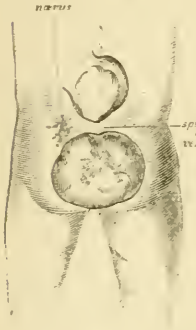
Dissection of Spina Bifida.

Characters of the Tumor.—The spinal hernia is sometimes covered by the whole thickness of integument; at others the integument, though present, is very thin: while occasionally the walls are represented only by a transparent membrane. This last condition was present in ten out of twenty-seven consecutive cases that have fallen under my care. The tumor may have a broad base and free communication with the spinal canal, or a narrow and more or less pedunculated one. Under the former circumstances, the probabilities of the cord being directly involved are greater than under the latter. The tumor is always more or less globular, tense, and elastic. When the child is asleep or quiet, the swelling may be soft; but when the child cries, the tumor will rapidly fill out. The edges of the bony orifice are occasionally to be felt. The integument is in some instances ulcerated even at birth, while in others there will be a small opening in the walls, through which the serous spinal fluid exudes.

Associated with Hydrocephalus.—The tumor is often associated with hydrocephalus, and in exceptional instances is double (Fig. 87). A nævus is not seldom found situated over the tumor. Such complications as club-foot or paralysis of the lower limbs frequently coexist with it, and under such circumstances it is tolerably certain that the cord is included in the hernia: and possibly the nature of the deformity may have been determined by the special nerves which are involved. Paralytic symptoms are more common in the broad-based hernia than in the narrow. Incontinence of urine or of feces may coexist with the paralysis or be independent of it.

The lumbo-sacral portion of the column is more frequently affected than any other, but the cervical and dorsal portions are also liable to the defect. Thus, in twenty-seven examples which came consecutively under my care, thirteen occurred in the lumbar region, four in the lumbro-sacral, and nine in the sacral. One was double, a small tumor being in the lumbar and a large one in the sacral region (Fig. 87). Twelve of these cases were uncomplicated with any paralysis or deformity. In eleven there was incontinence of urine and feces, associated in four with paralysis of the lower extremities. Four were complicated with hydrocephalus, two with nævus, and one with talipes. I have seen but two examples in which the tumor was in the cervical region. When the tumor is complicated with hydrocephalus, fluctuation may often be felt between the two parts, pressure on the head causing a fulness of the spinal hernia, and *vice versâ*. In exceptional cases the spinal hernia may protrude on the anterior part of the spine.

Fig. 87.



Double Spina Bifida. (From Eliza F——, æt. 3 months.)

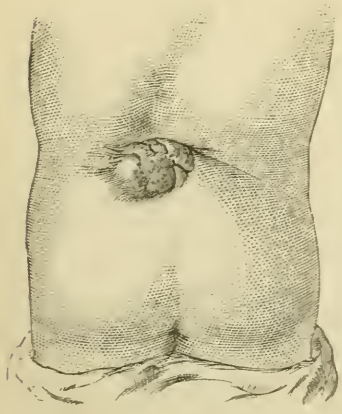
Diagnosis.—In a general way, there is no difficulty in diagnosing a spina bifida. In any infant a congenital tumor over the spine is probably a spina bifida: if globular and tense or capable of becoming tense when the child cries, the probabilities are almost converted into a certainty, inasmuch as the only cases for which this affection is liable to be mistaken are congenital tumors unconnected with the spine—cystic, fibrous, fatty, or fœtal tumors. These may be hard and tense, but they are rarely, if ever, made so much more tense from the child crying, as is the spinal hernia.

Prognosis.—The majority of these cases prove fatal. Many of the subjects are ill-developed and die within a few days of birth; death from convulsions is very usual when the sac bursts and its fluid contents escape, more particularly when the escape is rapid. The rupture of the sac is not, however, necessarily followed by this result. I have watched a child with this affection for four years, in which at birth the tumor was transparent and soon burst, and subsequently discharged at intervals for three years: it has now gradually contracted up into a solid mass. This case is an example of a natural cure, which takes place by the gradual approximation of the bony walls and closure of the orifice of the hernial sac. The more pedunculated the tumor, the better the prognosis, so long as no complication exists that threatens life.

Treatment.—Palliative treatment is all that can be adopted in the majority, although in exceptional instances operative interference promises to be of service. The tumor must always be guarded from injury by some soft protective material, such as cotton-wool or spongio-piline. Slight pressure sufficient to prevent rapid increase of the tumor is also beneficial, and the best method of applying it is by a casing of gutta-percha or felt moulded to the part. The application of collodion is sometimes useful.

Successful cases are recorded in which tapping of the hernia has been performed. The practice, however, is dangerous, as the drawing off of the fluid has been followed by convulsions, and even death. Nevertheless, it is the least formidable form of practice that can be undertaken, and should always be employed before more active treatment is resorted to, if only as a preliminary measure. The puncture should always be made at the side of the tumor, for the cord when present is probably placed in the median line. The whole of the fluid should never be drawn off at once.

Fig. 88.



Cured Spina Bifida. (Taken from a man æt. 26.)

Fig. 88 represents a case cured by puncture. It occurred in the person of a man æt. 26, who came under my care at Guy's Hospital in 1874 for some ulceration of his left foot, which, with the left lower extremity, was wasted from infantile paralysis. He had also a lateral curvature of the spine toward the right side and a cured spina bifida in the lumbar region. I discovered from the patient that he had been treated for the spina bifida by Mr. W. E. Image of Bury St. Edmund's, who, in answer to a note, kindly sent me the following account of the case:

"The child was brought to me when about two years old because the tumor was increasing in size, and convulsions were produced whenever

any pressure was applied to the tumor, even from the weight of the body when placed in the supine position. The tumor was large and semi-transparent. I punctured it obliquely with a darning-needle at intervals of two or three days, four or six times, and applied a compress of lint by means of strapping over the tumor. After this the fluid was not again secreted, the convulsions ceased, and the case got well." At the present time a hard puckered tumor alone exists to indicate the affection. A model of the case may now be found in Guy's Museum.

Dr. James Morton of Glasgow has advocated the injection at intervals of seven or ten days of half a drachm of a solution made by dissolving ten grains of iodine and thirty grains of iodide of potassium in an ounce of glycerine. The injection should be thrown into the sac after the withdrawal of some small portion of the spinal fluid. Dr. Morton reports (*Glasgow Med. Journ.*, May, 1881) that out of twenty-nine cases operated upon there were but six failures. This success is encouraging. The operation, however, has its dangers. In a case of my own, after the second tapping, there was so much draining of the fluid from the cord that the child died from exhaustion. After death there were no signs of inflammation of the membranes.

In no case where the base or neck of the tumor is large, nor in others in which it is evident the cord is implicated or large nerve trunks are involved, should this or any other operation be performed. In pedunculated tumors it may be attempted.

With respect to the *excision* of the tumor, a successful case has been recorded in the *Path. Soc. Trans.*, vol. xiv., in which Dr. Wilson of Clay Cross removed the tumor five days after the closure of its neck by means of a clamp; and when excision is entertained, this plan is probably the soundest. It should, however, only be thought of when the neck of the tumor is narrow and there is no paralysis of the lower limbs or incontinence of feces or urine. In all broad-based tumors associated with paralysis operative measures are out of the question.

Exceptional cases of recovery are on record after every form of practice, but, on the whole, the results of treatment are not very encouraging.

Sacral and Coccygeal Tumors.

Congenital tumors are by no means unfrequent in the neighborhood of the coccyx or sacrum. They are sometimes composed of cysts, occasionally of fat or fibre tissue, and also of fœtal remains. They are generally central. Many of these have doubtless been described as false spina bifida, and in rare examples there is reason to believe they are cured cases of spina bifida, the sac of the hernia having been occluded at its neck by the natural contraction of the surrounding parts. I have seen one such case in an adult where the tumor was successfully excised. Mr. Pollock has recorded in the eighth volume of the *Path. Trans.* an example of a congenital fatty tumor which he successfully removed from the central lumbar region of a child æt. 7, and Mr. Athol Johnson, in the same volume, a rare case of fatty tumor clearly developed in the spinal canal itself. I have had occasion to remove a large congenital sebaceous cyst placed between the anus and coccyx from a child æt. 10, and from another child a tumor containing fœtal remains, situated between the sacrum and the bowel. I may further refer to a third interesting case of cystic tumor of the sacrum, possibly spina bifida, in which the cyst burst and complete recovery followed. The following are the brief notes of the two latter cases.

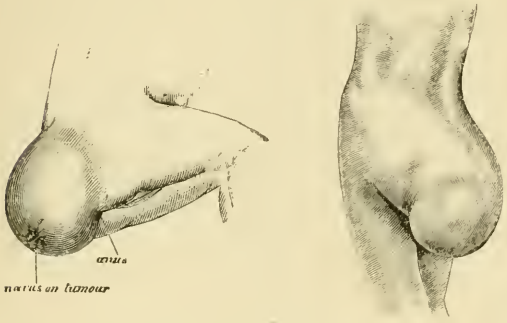
Marie B——, æt. seven weeks, was brought to me in 1868 with a congenital tumor the size of a large orange projecting from between the bowel and coccyx and apparently passing up in front of the bone (Fig. 89). It had been growing rapidly since birth and was pressing upon the bowel, though the child in all other respects was healthy. I excised the growth and found that microscopically it was made up of fat, fibro-cellular tissue, mucous membrane, cartilage, and bone elements. Recovery ensued, and the child has kept well.

A male child two days old was brought to me on July 30, 1868, with a large cystic tumor covering in the lower half of the sacrum and occupying the perinæum. It was the size of a cocoanut and transparent as a spina bifida, yet in all other respects the child was well formed. The next day it burst and many ounces of a blood-stained fluid escaped. The sac collapsed, but no evil result followed this bursting of the cyst. I watched the child for many months, and on November 30, 1871, the tumor had contracted up to an irregular indurated mass of integument. The child was very healthy.

Treatment.—The only effective treatment is the excision of the growth, which

should be done unless symptoms exist, such as extensive or dangerous connections of the tumor, to contraindicate the practice. Special care should be taken to ascertain that no communication exists between the tumor and the spinal canal.

Fig. 89. Fig. 90.



Congenital Coccygeal Tumors.

Fig. 90 represents a most interesting case, the particulars of which were kindly forwarded to me by Dr. Mercer Adams of Boston, Lincolnshire, who operated. The tumor was successfully removed from a female child æt. 10, and measured 22 inches in circumference; it was composed of cysts, and the largest, which was central, was lined with true skin covered with long silky hairs. This cyst contained thick putty-like material. From one of its walls grew an improperly developed fœtal leg and foot having three toes with perfect nails. There were also several curiously shaped fœtal bones scattered through the tumor—one like two coalesced ribs, and another a parietal bone. The tumor had deep pelvic attachments, and had to be dissected from the rectum. The lower part of the sacrum merged on the tumor.

Hewett, *Med. Gaz.*, vol. xxxiv.—Behrend, *Journ. f. Kinderkrankheiten*, vol. xxxi.—Nélaton, *Path. Chir.*, vol. ii.—Holmes, *Surgical Treatment of Children's Diseases*, 1869.

INJURIES OF THE SPINE, CONCUSSION, ETC.

The spine is a flexible tubular column composed of ring bones alternating with a dense elastic intervertebral substance. These bones articulate by means of joints, and are bound together by strong yet elastic ligaments. From the upper orifice of the tube the spinal cord with its membranes is suspended in a chamber filled with cerebro-spinal fluid and surrounded by large venous plexuses. The cord terminates opposite the second lumbar vertebra, but the membranes are continued down to the second piece of the sacrum. It is suspended in position by the nerve trunks that pass with the processes of dura mater that accompany them outward between the bones.

A local injury to the spine, such as a forcible bend forward, may sprain or lacerate the ligaments that hold the bones in position. A still more forcible bend may crush the bodies of the vertebræ that form the anterior portion of each ring. If the force be still continued upon the broken bones, displacement may take place, when the delicate cord itself will either be slightly pinched between the displaced bones and contused or completely crushed or divided. In the cervical and lumbar regions—not in the dorsal—the bones may be dislocated, the amount of injury to the cord depending entirely upon the amount of displacement that has taken place. When such displacement is very slight, the cord may be uninjured. Sprains of the back may also at a later period be followed by disease both of the joints and bones of the spine.

A diffused injury to the spine, such as that caused by a fall from a height upon the back or by a heavy falling body, may produce some fracture or dislocation of the bones of the spine, but it must to a certainty likewise cause a severe shaking, as from a railway accident, or a concussion of the spinal cord itself, as manifested by a more or less complete suspension of all the functions of the cord, either for a short period or for life. This concussion or shaking of the spine may be accompanied by hemorrhage into or upon the cord, giving rise to compression, or may be followed by acute or chronic intraspinal inflammation, terminating in paralysis and death.

In *both local and diffused injuries of the spine the gravity of the case depends chiefly upon the amount of injury the cord has sustained;* a severe local injury to the osseous part of the spine can be completely repaired without danger to life, whilst any injury to the cord and its membranes is fraught with danger, either directly by suddenly arresting the functions of the parts to which the injured nerves are distributed, or indirectly by setting up chronic inflammatory changes in the cord.

Concussion of Spine.—When the functions of the cord have been directly suspended by any local or diffused injury to the spine, the patient is said to have suffered from *concussion of the spine.* Should the symptoms be complete and persistent, there is

good reason to believe that the cord has been crushed by some displacement of a fractured or dislocated bone. Should some interval of time have taken place between the receipt of the accident and the paralysis, there is a fair suspicion that the paralysis is the result of some hemorrhage into or around the cord. Should the paralytic symptoms have followed the accident after a few days and be attended with constitutional disturbance or spasm of the muscles of the limbs, the cause of the paralysis was probably some inflammation of the cord and its membranes; and should the paralysis have been of a slow and progressive nature, the probabilities are that it is the consequence of some chronic softening of the cord, because all these different results have followed local and diffused injuries to the spine. Moreover, it is the knowledge that they may take place which renders any spinal injury a matter of importance, both as regards the immediate effects of the injury and its secondary consequences. I am bound, however, to add that Mr. Page in his recent interesting book on spinal injuries "doubts whether any passing paralysis following a severe blow on the vertebral column is not most likely to be due to the pressure of extravasated blood, which in course of time becomes absorbed," for he states that "we know of no case, nor can we discover the history of any, where a transient paraplegia or a suspension of the functions of the cord has followed a blow or fall upon the spine."

In rare instances symptoms similar to tetanus follow spinal injury. I have seen such in two cases. One was that of a man æt. 35, who fell from a height on his head, bending the neck forward. He was paralyzed for a few hours from the neck downward, and on the appearance of reaction had marked tetanic symptoms with the contracted brow and risus sardonicus. Spasms could be excited on the slightest touch being applied to his neck. In twelve hours, however, all these symptoms disappeared, and recovery ensued.

In the second case a man received a crush in the loins between two carts. Lock-jaw followed, with general spasms of all the muscles of the body. In five hours the spasms subsided, but they were followed for five days by hyperæsthesia of the integument, and on the sixth day by weakness of one leg. In a month he was convalescent.

Analogy between Spinal and Cerebral Injuries.—In former chapters it was shown that the functions of the brain may for a time be interfered with or suspended by a simple shake or concussion of its substance: that a severe concussion may give rise to contusion of the brain, either at the seat of injury or on the opposite side by *contre-coup;* that extravasation of blood either upon the surface of the brain or within its structure may follow such an injury; that fractures of the skull are of importance in proportion to the severity of the intracranial complications: and that intracephalic inflammation is too frequently the result of any head injury. In injuries to the spinal column and its contents similar results have to be recorded. A *simple concussion* or shaking of the spine may produce a partial or complete suspension of the functions of the cord, yet by rest and quiet these symptoms may disappear and a perfect recovery follow. A *more severe shaking* may give rise to some injury of the nervous structure, to some extravasation of blood upon or into the cord itself. Such a complication will necessarily be associated with more marked symptoms, more complete and persistent paralysis and anæsthesia of that portion of the body supplied with nerves from the injured centre, the completeness and persistency of the paralysis and anæsthesia depending upon the severity of the mischief and on the seat of injury. When the paralysis is severe, but *incomplete*, there will be retention of urine, this symptom arising from loss of voluntary power over the muscles that regulate micturition. But when the paralysis and anæsthesia are *complete*, there will be absolute paralysis of the bladder and all its muscles, with incontinence of urine. This incontinence, however, must not be confused with the dribbling of an overdistended viscus from retention, the incontinence of retention of Gross, such as occasionally occurs in the less severe cases.

When the injury is in the cervical region, one or both arms may be more or less paralyzed; when in the lower dorsal, one or both legs; but, as a rule, the paralysis is symmetrical and the symptoms depend on the nerves that are involved. The loss of sensation is also generally complete. In one case, however, there may be paralysis of one limb and loss of sensation of the other; in a second, exalted sensibility with paralysis. In one the power of motion may be regained, while that of sensation remains lost, and in another the reverse; indeed, on these points there is every possible variety, the seat of injury clearly determining the nature of the paralysis.

Brown-Séquard's observations and experiments on the decussation of the motor and sensory fibres of the cord have done much toward the elucidation of these points, and it

may now with some confidence be asserted that when one antero-lateral column of the cord is divided or irreparably injured there must be motor paralysis of the same side of the body below the seat of injury and loss of sensation upon the opposite side of the body, the motor paralysis being due to the destruction of the white substance and the loss of sensation to that of the gray.

When any portion of the white substance is left intact, some motion will remain; and when any part of the gray is uninjured, some sensation. Complete division of the cord is necessarily followed by complete paralysis and loss of sensation in the parts below, although, by what is called reflex action, the muscles of the parts may be made to contract on the application of any stimulant, such as tickling, to the sensory nerves.

Pain in the course of a sensory nerve or in an extremity is to be taken as representing the irritation of the cord or nerve at its central origin, and in cases of fracture as the spot where the bone has been broken. Symmetrical pains mean central mischief; unilateral pains, local.

A severe blow upon the upper cervical region may produce, according to Erichsen, instantaneous death from concussion When the *vagus* nerve is affected, a sense of suffocation, with irregular action of the heart or constant vomiting, may be produced. When the *spinal accessory* is injured, spasm of the trapezius or sterno-mastoid muscles occurs; and irritation of the *phrenic nerve* causes hiccup, as well as the sensation of an iron-band-like constriction round the body. When the injury is in the lumbar region, the paralysis is always partial, as the cord terminates at the second lumbar vertebra.

The *temperature* of the paralyzed limb is always lower than the rest of the body, even when to the patient it may feel hot or burning.

The PROGNOSIS in any case of concussion of the spine depends entirely upon the changes that are produced in the cord by the injury, and these are fairly to be measured by the severity of the symptoms and their *persistency*. This latter guide is very reliable, the persistency of symptoms being generally indicative of organic change. Again, when organic change has taken place, there is the greater probability of some secondary inflammatory action in the injured part, and on this the prospects of the case hinge; for in injuries to the spinal cord or membranes, as in injuries to the brain, this intracephalic or intraspinal inflammation is the cause of danger or of death in every case that survives the immediate effects of the accident, while it leaves, even when life is spared, more or less complete paralysis of the parts below the seat of injury.

INTRASPINAL INFLAMMATION.—SPINAL PARALYSIS AFTER CONCUSSION.—RAILWAY CONCUSSION.

Intraspinal Inflammation.—"Every injury of the spine should be considered as deserving of minute attention. Inflammation of the cord and its membranes may supervene upon very slight injuries of the spine; it may advance in a very insidious manner even after injuries that were of so slight a kind that they attracted at the time little or no attention." Thus wrote Abercrombie in 1829, and his observations are as true now as they were then; indeed, it is upon such views that the whole treatment of injuries to the spine, simple or severe, ought always to be based.

The preventive treatment of spinal as of head injuries means the adoption of such measures as experience has proved are most valuable in warding off the accession of intraspinal and intracephalic inflammation and thus preventing paralysis. The simplest shock or concussion of the spinal cord, the slightest blow upon the spine or sprain of its ligaments, any bruising of the former or laceration of the latter, and, *à fortiori*, any severer lesion, is apt to be followed by an acute or chronic intraspinal inflammation, and by changes in the structure of the cord that may give rise to a paralysis, partial or complete. The surgeon has, moreover, no guide by which to measure the danger or calculate the probabilities of the occurrence of this secondary inflammation, since it may follow a slight accident and fail to follow a severe one; at the same time, the prospects of its appearence and its danger depend much upon the gravity of the injury.

When the cord has been much contused or crushed by a fractured or dislocated vertebra, the paralysis that necessarily follows such a lesion is not likely to be aggravated by any secondary inflammatory changes in the injured cord, although the termination of the case may be hastened by these changes. Under such circumstances, the complication is not of such a nature as to add to the surgeon's anxiety. In less severe examples of injury, however, in which the primary symptoms do not indicate any organic lesion beyond that which manifests its presence by some temporary suspension of the functions of the

cord, it becomes a matter of primary importance to recognize the very earliest indication of inflammatory action, in order that it may be arrested; for, as it has been shown that the chief aim in the treatment of all these injuries is to prevent the occurrence of inflammation, so the second is to try and arrest its progress as soon as it has appeared. When it has become thoroughly established, neither medical nor surgical art has much power in checking its progress or in correcting its effects, as the delicate structure of the spinal cord appears to be incapable of undergoing material repair when softened by disease or crushed by accident. The cord structure, when once destroyed, is replaced by means of a fibrous substance. Paralysis or loss of function, under these circumstances, is permanent. In any case, therefore, of spinal injury, when the symptoms are persistent or tend to become worse, when after their partial or complete disappearance for three or four or more days they recur or appear in some altered form, when local pain is increased and movement of the back is more difficult or distressing, when pain follows the course of the nerve trunks that emanate from the injured spinal centre and muscular spasm or paralysis is present, and, moreover, when constitutional disturbance or general febrility is present,—when any or all of these symptoms, few or many, are found to follow a spinal injury after the first effects of the accident have passed away, the diagnosis of secondary inflammation of the cord may fairly be made and action taken upon it.

In *general concussions of the spinal cord*, more particularly from railway accidents, when, owing to some general shaking of the body, the spinal, cerebral, sympathetic, and circulatory systems are all more or less involved, there is an undoubted disposition for a chronic inflammatory change of a most insidious and creeping kind to supervene. In some cases, however, the change is rapid, as in the case of a man æt. 46 who was admitted into Guy's with complete paralysis and loss of sensation of his body below the first rib, the result of a fall down twelve stairs the day previously. The day following his admission some slight feeling returned in his body, and a few days later he could move his legs. The paralysis, however, never left him, and he died on the thirty-eighth day, of lung disease. After death the spine was found uninjured, but the spinal cord opposite the sixth dorsal vertebra was soft and diffluent and contained granules. There was no trace of effused blood.

It is now well known that the primary spinal symptoms are often so mixed up with the general as to be masked, and, beyond a general but temporary loss of power and consciousness, there is often nothing special by which spinal mischief is manifested. On recovering from the shock of the accident and the mental disturbance the sufferer often feels no definite injury, no special local symptoms, and it may be that it is not till after some time has elapsed—the duration of which is also uncertain—that any special symptoms make their appearance.

It will then probably be found that the patient has never been himself since the accident; he has been unable to work, mentally or physically, with the same force or energy that he did previously, is irritable in his manner, and perhaps feeble in his powers. Sleeplessness, too, has been more complete or common than it was before, and headache with general malaise now often exists.

Premonitory Symptoms.—Some slight unsteadiness of gait is often the first observed symptom, a feeling of heaviness in the limbs, some abnormal sensation, such as that of pins or needles, numbness along the course of a nerve, cramps, perhaps retention of urine, or some evidence, in fact, of want of control or power over the muscular apparatus, and more marked generally in the lower extremities than in the upper. The centres of sensation may, at the same time, show indications of disturbance, either by a state of lessened sensibility or perhaps by a hyperæsthetic condition. From symptoms such as these the attention of the surgeon is probably arrested. On testing the muscular apparatus thoroughly it will probably be found that the patient will be unable to stand steadily on one leg, or, what is a better test, if he place his heels together, he will totter on making the attempt to raise his body on his toes. When asked to stoop to pick up anything from the ground, he will probably bend his knees rather than his back and walk with a rigid spine. On giving him a small object, such as a pin, he will take it clumsily and with tremor—will fumble at most things with his hands and stumble at anything that is in his way.

On examining the spine some tenderness may be manifested on firm pressure, but probably only in certain places. Percussion on the bones is hardly a fair test; when employed, it should be indirect, through the fingers. Pressure applied to the spine causes at times severe pain, as does any movement; it is the latter condition which induces the rigidity of the spine in walking, before alluded to.

The brain and organs of special sense may likewise be affected, either by over- or under-sensibility. *Vision* may be imperfect either in one or both eyes; *hearing* may be over-sensitive or defective; *taste* and *touch* may be perverted or lost and *smell* at times destroyed or morbid. In fact, the whole nervous system, cerebral and spinal, may be disturbed and its functions more or less damaged.

The course which such cases run is very uncertain, and the prognosis is therefore difficult. When the motor-power has been lost from spinal mischief, the best test is galvanism. A healthy muscle supplied from a healthy nerve centre will always contract on the application of the galvanic current. When the nerve centre is so diseased as to cause paralysis, the galvanic current produces no movement—no contraction. This test is beyond the patient's control and cannot be resisted; it is consequently valuable.

Caution in Interpreting Symptoms.—In interpreting these symptoms, more particularly in a railway case, or in any where the question of damages is involved, it is most important for the surgeon to separate the symptoms of which the patient complains, the *subjective*, from those he can himself perceive, the *objective*. Let him doubt and cross-examine in every way upon each of the former to test their accuracy. He may rely, however, upon the latter, and any positive opinion ought to be based upon these alone. There always hangs a suspicion over the former because self-interest points to making the worst of them.

All the symptoms, taken as a whole, undoubtedly indicate a chronic or subacute inflammatory change of nerve tissue, an inflammation of the membranes or of the cord. When they appear as a consequence of a general concussion of the spine, the cord is probably the seat of mischief, its delicate structure being more liable to injury than the tougher membranes, and, consequently, to secondary changes. When they follow some local injury, such as a twist, blow, or forcible bending of the back with laceration of ligaments, the disease in the cord probably is secondary to disease in the membranes, the inflammation of the latter being due to the extension of inflammatory action from the injured part inward. "Inflammation of the membranes of the cord, as of the brain, is a disease not idiopathic, but proceeding from some cause without." But whenever this commences it is progressive, and in the end involves all the tissues in its destructive changes.

Pathological Changes.—The pathological changes themselves are tolerably definite. In the cord they put on the appearance of red softening in recent disease, and of white in chronic. The parts are soft and pulpy, the microscope showing them to contain granule corpuscles and elements of the inflammatory process. The white matter of the cord will appear at times sound, while the gray substance is soft. The disease may be local or more general. In concussion the latter is the more common condition. When it is in the cervical region, death is rapid; when in the lower dorsal, life may be prolonged for some time. This fact is well illustrated in fracture and dislocation of the spine.

Treatment.—In all cases of concussion of the spinal cord, simple or severe, *absolute rest* in the horizontal posture is most essential, and in mild cases this is probably the only treatment called for; the symptoms, by the observance of this rule, gradually disappear, and the health is restored. The prone position in more severe cases is generally to be preferred to the supine, but the best guide in this matter is the ease which the patient experiences. The surgeon, however, must enforce quiet for many days after the disappearance of all symptoms, even in the mildest cases, on account of the primary danger of intraspinal inflammation, and the period of rest to be enforced must be in proportion to the severity of the symptoms. In cases of railway concussion this practice is of primary importance, and I am disposed to attribute the frequent occurrence of obscure railway spinal cases to the non-observance of this rule. It is true that in the majority of cases there are no definite indications of spinal injury after the accident, though the nature of the accident itself is a sufficient guide to the case. A general shaking of the body means a general concussion of the spinal cord with every other part, and the nerve centres, by reason of their structure, are most liable to injury. It would be well, therefore, to keep all patients who have been the subjects of such injuries quiet and in repose for several weeks after the accident. By doing this much mischief would often be avoided.

After concussion, when severe local pain is experienced, relief is often given by the application of a dry cupping-glass on either side of the painful part, and the operation may be repeated. In exceptional cases the local extraction of blood may be found of benefit. The application of cold is a powerful remedy for good when there is much effusion of blood or pain in the part, and when the symptoms of reaction are too marked.

The diet should be nutritious, but unstimulating, and nothing likely to keep up or cause mental or physical excitement allowed. When recovery of power in the limbs is slow and no symptoms of secondary inflammation of the cord exist, convalescence is promoted by the application of electricity in one or other of its forms to the enfeebled muscles.

When symptoms of intraspinal inflammation have appeared, some advocate moxas or setons in addition to the above treatment; and of the two the moxa is, perhaps, preferable. Mercury in one of its forms appears to be a valuable remedy, and the perchloride is perhaps the best preparation, given in doses of one-sixteenth of a grain two or three times a day combined with bark, quinine, or some other vegetable bitter according to the wants of the patient. When mercury is inapplicable, the iodide of potassium should be substituted. Sedatives should be allowed, to procure sleep, and the hydrate of chloral seems to be the best, in twenty- or thirty-grain doses, at bedtime. Should pain be constant, fifteen grains of the same drug may be given twice a day, a double dose being allowed at night. The extract of belladonna in one-third of a grain or half-grain doses is likewise a valuable sedative. Strychnine is a dangerous drug in spinal disease—at least, in progressive spinal disease. It is a distinct stimulant to the spinal centres, and is consequently most injurious as long as any progressive inflammatory action exists. When only the effects of the disease remain and all inflammation has ceased, strychnine may be given. Should general feebleness exist, iron may be given with it; and I know of no nervine tonic so beneficial as the combination of the tincture of the perchloride of iron in doses of fifteen minims with five minims of the tincture of nux vomica or one or two grains of quinine. Cod-liver oil is a valuable adjunct to all treatment in this as in many other cases.

Great care should be observed throughout the treatment of these affections to prevent the occurrence of bedsores. They form very rapidly when spinal paralysis is present. I have seen several instances in which all the soft parts over the bones sloughed and the spinal canal was opened, while in others the sacral bone may partially exfoliate. The back should be kept very clean and dry and occasionally sponged with spirit lotion or spirits of camphor. It should also be protected further by leather strapping, felt plaster, and by cushions of air or water.

When retention of urine complicates the case, the utmost caution is required in passing the catheter. An elastic instrument should be preferred and of a large size, the French vulcanite catheter being the best. The catheter should be kept scrupulously clean.

FRACTURES AND DISLOCATIONS OF THE SPINE.—WOUNDS AND SPRAINS.

In a practical point of view, it is expedient to consider fractures and dislocations of the spine together. They are not, however, invariably combined, for, although in four-fifths of the injuries to the spinal column involving the bones some fracture is present, in the remaining fifth simple dislocation exists. The majority of these cases of pure dislocation occur in the cervical region; in the dorsal such an accident is almost impossible, while in the lumbar it is very rare. The difference in the anatomical arrangement of these divisions of the column affords an explanation of these facts. To the practical surgeon these points are, however, of small importance; that which concerns him the most in any injury to the spine has reference to the cord: How much injury has it sustained? Is it reparable or not?

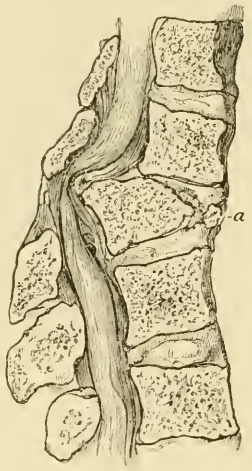
When complete paralysis follows the injury, there is little doubt that the cord has been injured. It may be that it has been more or less completely crushed, or even divided by displaced bone. In less severe injuries, less severe symptoms show themselves. The nearer the injury is to the respiratory centre, the greater the danger; thus injuries of the cervical are more dangerous than those of the dorsal region, and these again than those of the lumbar. Any crushing of the cord above the third cervical vertebra is, as a rule, followed by instant death, this point being above the origin of the chief respiratory nerve, the phrenic. In cases of injury to the cervical vertebra giving rise to any symptoms of paralysis death generally takes place within three days, and commonly within two. Thus, out of thirty-six fatal cases extracted for me by Mr. Rendle from the Guy's records, twenty-five died in less than seventy-two hours and twenty in less than forty-eight; eight only survived the former period, and in those there were no symptoms of paralysis as an immediate result of the accident. Eleven of the thirty-six were cases of pure dislocation, twenty-five were examples of fracture and dislocation combined, and all

were below the third cervical vertebra. In every case, also, of dislocation the upper vertebra was thrown forward upon the lower, as seen in Fig. 91. The reverse holds good

Fig. 91.

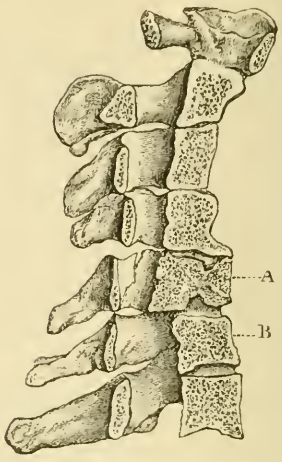
Dislocation of the Spine Forward. (Guy's Hosp. Mus., No. 1033.)

Fig. 92.



Fracture of Spine and Displacement of Upper Vertebra *Forward*. (Guy's Hosp. Mus., No. 1035[25].)

Fig. 93.



Fracture of Spine and Displacement of Upper Vertebra *Backward*. A fifth, B sixth, vertebra.

only in exceptional cases, as in the one illustrated by Fig. 93, in which a man æt. 20 struck his head against the bottom of a bath when jumping for a dive a height of twelve feet. The drawing shows a displacement of the fifth cervical vertebra *backward*, with a fracture of the fourth and fifth and crushed cord. The man lived seventeen months.

Fractures of the dorsal and lumbar vertebræ associated with displacement and giving rise to paralysis below the seat of injury are less speedily fatal than those of the cervical region.

Fracture of the spine may, however, take place and not be associated with any paralysis. The spinous processes of any of the vertebræ may be fractured and no spinal symptoms follow. This accident is generally the result of a direct blow. When I was a dresser, I saw a case of fracture of the spinous processes of three cervical vertebræ associated with a temporary paralysis, and in this instance complete recovery ensued. I have since treated successfully a case of fracture and displacement of the spinous process of the fourth cervical vertebra without paralysis.

In other cases fracture of the spine may take place and not be detected until after death. Thus, in 1879, a man æt. 23 was admitted into Guy's Hospital under Dr. Wilks for some throat affection, as suggested by difficulty in swallowing and inflammation of the soft palate, with a sloughy patch of tissue in the pharynx. The symptoms had come on after a fall of ten feet down a ship's hold three days previously. There were no symptoms of paralysis. The man died on the fifth day of his admission and eighth day after the accident with dysphagia as his most prominent symptom, associated with febrile disturbance and delirium with tremor. After death the body of the fifth cervical vertebra was found fractured and its lower fragment projecting forward. The cord was not affected. There was a sloughing prevertebral abscess communicating with the pharyngeal wound which had been clearly caused by the fractured fifth vertebra. A portion of the laminæ of the fifth vertebra was necrosed and bathed with putrid pus, which had spread upward to the base of the brain and caused death. In 1857 a woman in an attack of mania was admitted into Guy's under the care of Mr. Cock for some contusion of the back caused by a fall out of a window. Beyond the contusion, no injury could be made out. There was no paralysis, but, on the contrary, violent muscular movement. On one occasion the patient got out of bed and struggled to open a window to throw herself out. She lived sixteen days, and during the last week of her life rested quietly in bed with her eyes closed. She would only at times rouse herself and speak. After death atrophy of the brain was found, with general fatty degeneration of the viscera. The last dorsal and three upper lumbar vertebræ were fractured through their bodies, but not displaced; one or two spinous processes were also fractured. The spinal marrow was uninjured.

The fact of there being no displacement of the broken bones and no injury to the cord prevented a correct diagnosis being made.

I have seen also a case of fracture of the spinous processes of the last dorsal and the first lumbar vertebræ, with lateral displacement, the injury having been treated for some months previously as a simple contusion of the back. In this case no paralysis existed or other spinal symptoms.

Fractures and dislocations of the spine are generally the result of *indirect forces*, such as severe falls. A forcible bending forward of the cervical spine may cause dislocation of the cervical vertebræ, and a similar accident to the dorsal spine may cause fracture. In these cases, too, there is always some laceration of the ligaments and crushing of the anterior edges of the bodies of the vertebræ. (*Vide* Fig. 92.) A forcible bending backward of the spine may produce a like result, the laminæ of the dorsal or lumbar vertebræ, under these circumstances, being much broken. Direct violence to the cervical region of the spine may produce dislocation; whilst to the lower vertebræ it generally causes fracture of the spinous processes or laminæ. Mr. Holmes has recorded in the *Path. Soc. Trans.*, vol. x., an interesting case of displacement of the last dorsal from the first lumbar vertebra, associated with some slight fracture of the processes the result of a direct blow.

Fracture of the sternum is not uncommonly associated with injuries to the spine from the forcible bending forward of the head. It was found in four out of fifty-six fatal cases that occurred at Guy's.

Of these fifty-six fatal cases of fracture and dislocation of the spine, thirty-six were of the cervical region, eleven being examples of pure dislocation, eighteen of the dorsal, and two of the lumbar, injuries of the cervical being apparently twice as frequent as those of the dorsal region, the greater mobility of the cervical vertebræ and the obliquely horizontal aspect of their articular processes favoring dislocation.

In the thirty-six the injury was below the third cervical vertebra in all but three examples. In one of these it involved the second, third, and fourth vertebræ; in another, the arch of the atlas and spinous processes of the second and third vertebræ; and in the third case the bodies and arches of the third, fourth, and fifth vertebræ.

In the eighteen dorsal seven were in the upper and eleven in the lower half, the lower part of the cervical and of the dorsal regions being clearly more liable to injury than the upper.

When the cord was sufficiently injured in the cases of injury to the cervical region to give rise to paralysis, death generally took place within three days, and in the majority of instances within two.

When it occurred as a result of injury to the dorsal region, suppuration of the kidneys, cystitis, or bedsores were the most common causes of death.

Of the eleven cases of pure dislocation of the cervical vertebræ, four were between the fourth and fifth, two between the fifth and sixth, three between the sixth and seventh, and two between the seventh cervical and the first dorsal. In none of these was there the smallest trace of fracture. In six the displacement was so great as to crush the cord. In five there was no displacement and no marked paralysis as a direct result of the injury, although secondary paralysis appeared subsequently, from stretching or other injury to the cord.

In injuries to the cervical region pure dislocation occurs in thirty per cent. of the cases.

Cases of sudden death after a fall from a height upon the vertex are doubtless often due to a fracture or dislocation of the cervical spine. It may be a fracture of the processus dentatus of the axis, a laceration of the transverse ligament binding it in position, or a fracture of the atlas allowing the head to slip forward. Dislocation of the occipital bone from the atlas has been described; it is, however, very rare.

When fracture of the odontoid process takes place, as it may from external violence or during the progress of some disease in the vertebræ, death, as a rule, occurs suddenly, the victim being literally pithed. In other cases—and these, generally, of disease—the displacement may be gradual, death being then often preceded by paralysis of an arm or leg, or both, with difficulty in swallowing, pain in the neck, and inability to raise the head into the erect position or to rotate it.

Vide paper on fractures of the odontoid process, by Dr. Stephen Smith of New York (*American Journal of Med. Sci.*, October, 1871).

DIAGNOSIS.—When a patient has received a severe injury to the spinal column followed by *complete* paralysis, the cord has been injured, and it is probable that a fracture or dislocation, with displacement of the vertebræ, has taken place. When the paralysis

is *partial*, it is probable that the cord has been only partially involved, but more or less bruised or stretched, according to the nature of the accident and the extent of the displacement of the injured bones. When no paralysis is present, the diagnosis of fracture or dislocation is difficult.

When any inequality or irregularity in the spinous processes is present, any pain in one spot aggravated by pressure, any crepitus on manipulation, any local effusion of blood about the spine, any inability to move the spine or support the body; when priapism appears early in the case: when one or more or all of these symptoms come on after such an accident as is liable to produce them,—the diagnosis of a fracture or dislocation is tolerably clear.

When paralysis of an arm or leg follows a spinal injury, it is possible that the paralysis may be caused by pressure upon one or more of the nerves that pass outward from the spine, or by laceration of a nerve trunk from some partial displacement of the injured bone. When paralysis is incomplete, the motor-power is generally more completely lost than that of sensation; indeed, it often happens that there is hyperæsthesia in that portion of the body contiguous to the paralyzed part, owing to the portion of cord above the injury being overactive or irritated by the sharp parts of the fractured bone. Intense pain in the line of junction of the paralyzed and non-paralyzed parts signifies fracture, in Mr. Erichsen's opinion. In estimating the seat of injury from the position of the paralysis, it is right to remember that the nerves come off obliquely from the spinal cord and pass downward, the cervical and dorsal nerve trunks leaving the spine one or two vertebræ lower than the spot whence they are given off, while the cord terminates at the second lumbar vertebra. Thus, when fracture takes place below the second lumbar vertebra, the patient may be unable to stand or walk wholly or in part, yet there may be no paralysis, for place him on his back and there will be free movement of his legs. In other cases the nerve trunks around the cauda equina may be involved.

When a patient has received a severe spinal injury, there may or may not occur what is called "shock;" but when these symptoms have passed off and those of reaction appear, there will commonly, in cervical injuries, exist some throbbing of the arteries and increase of the temperature of the paralyzed parts. These conditions are due to paralysis of the arteries as a result of injury to their vaso-motor nerves. At a later period, however, this increase of temperature subsides and a diminution can be detected. In exceptional cases the vaso-motor paralysis is associated with coldness of the parts, and it is probable that when this coldness exists it is due to great depression of the heart's action.

Priapism is a common consequence of spinal injuries, and more particularly of cervical and upper dorsal. It may occur, however, in lower dorsal, not so in the lumbar. I have recorded an example occurring in the lower dorsal (*Path. Soc. Trans.*, vol. vii., p. 332).

Prognosis.—The nearer the injury is to the respiratory centre, the greater the danger to life. Thus, in injuries to the cervical spine above the origin of the phrenic nerve or third cervical vertebra causing paralysis, death may be instantaneous; when below this position, and the respiratory process is maintained only through the diaphragm, life is rarely prolonged beyond the third day, and, as a rule, not beyond the second. Exceptions to this rule, however, are met with. Mr. Hilton has recorded in his lectures *On Rest* a case in which a man lived for fourteen years completely paralyzed from the neck downward after a fracture of the cervical vertebræ, and in my own practice I had a case in the person of a gentleman aged 29, whom I saw with Mr. Roberts of Southgate, November 25, 1870, with complete paralysis of the whole body below the fifth cervical vertebra, caused by a fall upon the neck; he lived nearly ten years and died from lung disease, breathing solely by the diaphragm.

When the cord has been injured in the lower dorsal or lumbar region, life may be prolonged for many months, the immediate cause of death being generally some renal or vesical mischief, some bedsore or other complication the direct result of loss of nerve power in the paralyzed parts. The longer these complications are delayed by careful nursing and attention, the longer can life be maintained.

In other cases, again, in which only partial or no paralysis at all is present as a direct consequence of the injury, inflammatory changes may ensue in the injured part, and, spreading upward, cause death. The prognosis in such instances will be mainly determined by the seat of the injury and the extent of the mischief in the cord.

The lower the seat of injury, the better the prospects of a cure; and the less the cord is involved in the mischief, the greater the chances of a recovery.

Thus fractures of the lumbar region are quite capable of a complete cure, and fractures of the lower dorsal vertebræ are not unfrequently recovered from. Injuries to the

cervical part of the spine are generally fatal within three days. Injuries to the dorsal, when not proving fatal within the third week, may be survived for months, and even years, the duration of life being greatly determined by the warding off of the secondary complications which so frequently arise.

Treatment.—The diagnosis of a fracture or dislocation of the spine having been made, the most essential point to attend to is to keep the part absolutely unmoved. The patient should be examined with the greatest care and moved with every possible precaution, as any motion may add to the injury the cord has sustained and increase the danger to the patient. Extension of the spine may be employed when much deformity exists, and particularly when severe pain arises from nerve pressure, but extreme caution is required in following this practice; it is not to be employed in every instance, but only when local symptoms seem to suggest the probabilities of a reduction of the dislocated or displaced bone or the relief of pain. I have known cases in which a successful reduction of displaced bone has been effected by extension, and seen others in which marked relief was afforded by this course. Practised with discretion, extension of the spine is doubtless a valuable means of treatment. A good example of this occurred in the practice of my colleague, Mr. Davies-Colley, on March 14, 1883, when a man æt. 56 was brought into Guy's after having been doubled up forward, with projection of the first lumbar vertebra three-quarters of an inch behind the level of the last dorsal, and some paralysis of motion and sensation of the right lower extremity. Under chloroform powerful traction was made upon the legs by assistants, and Mr. Davies-Colley, whose hand was placed upon the projecting bone, felt it gradually sink to the level of the upper vertebra; at the same time crepitation and mobility were felt, as if the bone immediately above had been broken. A plaster-of-Paris jacket was then applied. For ten days the urine had to be drawn off. At the end of a month sensation had returned in the right leg, but the foot was in the position of talipes valgus from paralysis of the peronei muscles. The jacket was removed, and no deformity existed. The man could move in bed without pain. He left the hospital cured, but with the talipes.

When the injury is in the mid or lower dorsal region, the application of a plaster or other jacket, with the patient in a horizontal position, gives comfort by ensuring immobility and helps recovery.

When the patient is placed on his back, the parts have a natural disposition to fall into place; this position, therefore, must be maintained. The bed should be firm, yet elastic, and a water bed is the best when it can be obtained; otherwise, a spring mattress or one of horsehair should be employed. It should be well protected by waterproof cloth, etc. from all contact with urine or feces.

The condition of the bladder should be attended to from the very first. Retention is certain to be present for a time, and overdistension is most injurious. The utmost care ought to be employed in drawing off the water. A moderate-sized elastic or the French vulcanite catheter should be used, and the operation repeated twice a day, night and morning. If the urine becomes offensive, the bladder must be washed out with a lotion of boracic acid ten grains to the ounce; but no syringe should be used. A stream of medicated water ought to be allowed to run in and out of the bladder through an elastic tube attached to the irrigator and fitted to the top of the catheter, no force being applied. (*Vide* Fig. 359.) The application of leeches to the spine or cupping is seldom called for. The condition of the bowels must be attended to, and enemata are to be preferred rather than purgatives. The greatest care is needed to keep the patient clean, particularly when incontinence exists.

There are no special medicines applicable to these cases. The general health of the patient should be maintained by tonics and simple nutritious food, and sedatives should be given to procure rest and relieve pain.

The condition of the back must be daily watched to prevent bedsores. This is best secured by removing pressure as far as possible or in relieving it by means of soft cushions and pads, the water cushion being the best, and also by keeping the parts dry. The application of a soft felt plaster over the sacrum and hips is sometimes beneficial; so also is the frequent application to the parts of some spirit lotion. Should it be necessary to turn the patient on one or other side, the attendants ought to be taught to rotate the hips and shoulders at the same time. By great care and attention life may be prolonged, and even recovery may occur.

The subject of trephining the spine requires brief consideration. Cline was the first to put it into practice, and on his great authority the operation has been repeated, but with no success. The great argument, however, against the operation is

derived from the fact that in few post-mortem examinations has the condition of parts indicated that the slightest good could have been derived from its performance. The danger of a fractured or dislocated spine lies in the injury to the cord, the result of a stretching or crushing of its substance. When the cord is much injured by the accident, the mischief has been done, and no removal of the displaced bone can undo it or neutralize its evil. If the cord is uninjured, no operation is called for.

One successful instance of trephining is recorded by Dr. Gordon of Dublin, and in rare and exceptional cases it is possible the operation may be justifiable. To perform it because it may by chance do good is not advisable. The onus of proving that an operation is likely to be of use always devolves upon the surgeon who performs it. There is, however, reason to believe that a cord may at times be only squeezed or pressed upon by effused blood, and under such circumstances relief might be afforded by removing enough bone to take away the pressure and thus give the cord a chance of recovering itself.

In the case of Mr. Roberts's patient, referred to at p. 240, such a probability seemed reasonable, and three months after the accident I cut down upon the injured vertebra and removed the spinous process and lamina of the fourth cervical, thereby exposing the cord. No harm followed the operation, although no immediate good was produced. The wound healed rapidly, and in the course of a few weeks some slight power returned in the muscles of the shoulders, the patient being able to raise the arms from the bed. He, however, made no further progress; and yet I look upon the case as an encouraging one.

"The end proposed in an operation of this kind," says Le Gros Clark, "is to remove displaced bone which is supposed to press upon or irritate the cord; but it is most likely to prove abortive, from the inaccessibility of the displaced bone. If the cord have been crushed and the operation have been consequently useless, probably life may thereby be only curtailed; but if the cord be not crushed, it appears to me that the best chance of the patient's recovery is thereby extinguished. Indeed, my conviction is that the operation has been advocated on the erroneous hypothesis that the spinal cord can be compressed without serious disintegration of its texture."

Wounds of the Spinal Cord.

These are very rare in civil life. They may take place, however, as the result of a stab or gunshot wound. If the cord is injured, some symptoms of paralysis will appear corresponding with the part that is involved, the extent of the paralysis and its seat fixing the position of the wound. Mr. Holmes has recorded (*Med. Chir. Trans.*, vol. lxv., 1882) an interesting case, in which the theca vertebralis was opened in the lumbar region with a knife, and in which cerebro-spinal fluid escaped in considerable quantities for seven days without any bad result.

Sprain of the Back.

The word "sprain" is very broad, and when applied to the back is indeed vague. It may mean simply a stretching of the muscles or ligaments of the back, or a more complete laceration of the latter and separation of the spinous processes of the vertebræ, with exposure or injury of the cord. The number of articulations in the spine—nearly eighty—renders such an accident as a sprain a common occurrence; any twist of the spine or forcible flexion may consequently injure some of these joints. Sprains may, moreover, be followed by acute or chronic joint disease of a serious and insidious nature: and this truth should ever be before the surgeon to influence his practice. When the head is bent violently forward, the muscles and ligaments may be so torn as to give rise to effusion of blood, swelling, and severe local pain. When the body is flexed with violence not sufficient to give rise to fracture, there may be the same results; and so also when a man falls upon his buttocks. In each case there may be external evidence alone of injury, or there may be evidence of some affection of the cord such as is afforded by the presence of paralysis, proving that the cord has been stretched, if not permanently injured. If the symptoms rapidly, or even gradually, subside, no grave mischief, probably, may have taken place. When they are persistent or obstinate, a less favorable opinion should be formed. If the lumbar region is the part involved, it is not uncommon for hæmaturia to appear; and this may be slight and pass away or be more persistent. It is not generally a very serious symptom, unless the kidney is ruptured; as a rule, it dis-

appears gradually, and no evidence remains that organic renal disease is ever the consequence. "Of the many cases I have witnessed," says Le Gros Clark, "I have never had reason to suspect that nephritis or organic disease followed" (*Brit. Med. Journ.*, October 3, 1868). Mr. Shaw, in *Holmes's Surgery*, gives a case where the bleeding lasted for four days, ceased for two, and then reappeared in all its severity. After the lapse of two more days it again ceased for twenty-four hours, reappearing for a third time severely, then ceasing, and a good recovery followed. When the kidneys are diseased, and when calculi also exist in them, this symptom is more likely to appear after injury.

Hemorrhage into Spinal Canal.—Hemorrhage may take place into the spinal canal as the result of a sprain or laceration of the ligaments, the blood probably flowing from a laceration of some of the large veins that surround the cord or from a spinal artery. Sir P. Hewett has related a case of sudden death from a fall on the head, recorded by Dr. Deville in 1843 (*Mém. de la Soc. de Chirurg. de Paris*, t. iii.), in which no other injury was found to the nervous centres than hemorrhage into the canal in its whole length. Mr. Le Gros Clark has recorded a second, in which a man was struck violently on the back, though there were no immediate spinal symptoms. Paraplegia soon followed, however, which extended upward, destroying life by asphyxia; and after death the theca was found distended with fluid blood derived from a ruptured spinal artery. He gives also another case somewhat similar in symptoms, though not in result, where the patient recovered after two years.

TREATMENT.—In all these cases of sprain, slight or severe, rest is essential, the sufferer being allowed to assume the position in which the greatest ease can be obtained. The application of cold by an ice-bag or a metallic coil is also of great service where much swelling or pain exists. In other cases a warm poppy fomentation gives relief, or a mixture of belladonna and opium rubbed down with glycerine and applied on lint. When spinal symptoms are present, the greatest caution is needed, and the case ought to be treated as one of concussion of the cord.

In bad cases it is wise to fix the spinal column in a surgical casing, with the object of guarding against secondary inflammatory changes both of the spine and cord; and this absolute immobility of the spine should be maintained for months.

Rest in the horizontal position for seven or eight weeks is essential in less severe cases, and even in the mildest forms exercise must be sanctioned with caution.

When hæmaturia occurs, it requires no special treatment unless severe, when gallic acid in gr. v or gr. x doses two or three times a day may be given, or, what is better, the subcutaneous injection of ergotin in doses of two to five grains dissolved in five or ten minims of distilled water employed.

CURVATURE OF THE SPINE.

There are two forms of curvature of the spine—*lateral* and *angular*. The *lateral* is due to a relaxation of the ligaments and muscles of the spine, which in a healthy subject maintain the bony column in its normal position. The *angular* is secondary to organic disease of one or more of the bodies of the vertebræ or of the intervertebral substances, and is generally known as "Pott's curvature."

LATERAL CURVATURE OF THE SPINE.

This is by far the more common form of spinal curvature. It is generally found in girls between ten and twenty years of age, sometimes in young children, and is frequently, though not always, associated with want of power. It is more common in the middle and higher classes of society, where sedentary occupations and luxurious enervating habits too often exist, than in young women who make full use of all their muscles and lead an active life.

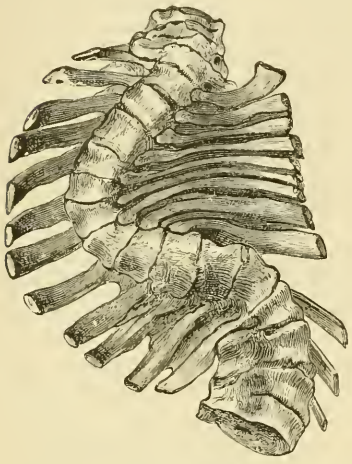
It is encouraged by any one-sided posture of the body, whether this be the result of some faulty habit or of occupation, of overuse of one limb, or of any disease or deformity of a lower extremity which occasions shortening of the limb.

In its early stage it is seldom discovered, and attention is, as a rule, drawn to the disease by some "growing out" of one shoulder, generally the right, some distortion of the chest, or some tilting upward of a hip. These deformities are frequently first noticed by dancing- or drill-masters. When a curve has taken place in the upper dorsal region of the spine to the right side, a compensatory curve is certain to be found in the lumbar to the left. In investigating a case it is important to bear this fact in mind, as the con-

secutive or compensatory curve, unless of long standing, will soon be remedied when the original one has been cured.

Associated with the lateral curvatures there necessarily must be some rotation of the spine. The amount of this is very variable and depends upon the extent of the curvature: it is doubtless due to the forcible bending of the bones downward with the ribs, these latter helping to rotate the vertebræ upon their axes. The bones may be so twisted that their transverse processes project backward, carrying the ribs with them, the anterior surfaces of the bodies of the vertebræ looking toward the convexity of the curve and the spinous processes laterally toward the concavity. The thorax is thus much distorted, the side corresponding to the curve being expanded and the opposite one greatly contracted. This is well seen in the annexed drawings, Fig. 95 taken from a living patient and Fig. 94 from a preparation.

Fig. 94.



Anterior view.

Fig. 95.

Posterior view.

Lateral Curvature of the Spine.
(Guy's Hosp. Mus., No. 1006[60]. Taken from Emma J——, æt. 14.)

In some otherwise healthy and in rachitic subjects there exists an exaggeration of the natural curves of the back. When it is in the upper dorsal region and backward, it is called "*cyphosis*;" when in the lumbar and forward, "*lordosis*." This latter curve is very frequently found as an accompaniment and result of hip disease when the thigh is flexed or adducted, and it is always present in congenital displacement backward of the head of the femur.

The DIAGNOSIS is not very difficult when the deformity is well developed, the double curve giving the spine a sigmoid form, which is typical. In less severe cases this curve can readily be removed by extension of the body, either by lifting the patient from the ground by a hand in each axilla or by—what is better—the vertical suspension of the patient by his hands from a bar or a pulley. In the more severe forms, such as that shown in the above figures, the deformity is permanent; the ribs are thrown out in an extreme degree, pushing the scapula outward and upward, and the lumbar curve is in the opposite direction to the dorsal. The whole thorax, abdomen, and pelvis are altered in shape and position by the deformity.

TREATMENT.—In treating these cases it is necessary in the first place to determine the cause of the deformity. Should there be any structural disease, such as a growth or carious bone, this will require attention, and the alteration in the spine becomes thereby a secondary matter. But in the great majority of cases of lateral curvature the spinal affection is the result of impaired health, and constitutional remedies are demanded. The treatment must be directed to an improvement of the general health, and tonics should be administered, such as iron, quinine, and cod-liver oil. Good air and good food are also essential. In certain cases local treatment is of great value.

The feeble muscles and weakened ligaments should have rest, though they are to be kept in health by moderate exercise; they are never, however, to be fatigued. If fatigue be experienced from walking one hour, such exercise must be curtailed to a shorter period. If backache be produced by exertion, less must be taken. Exercise is to be allowed, but not to the extent of producing fatigue. Sitting and standing ought not to be sanctioned. The patient should recline at stated intervals in any position that gives the greatest ease. When the deformity is definite and the dorsal curve is to the right side, as is nearly always the case, the patient should rest upon that side with a pillow beneath the right arm, the weight of the body in that position acting as an extending force upon the curved spine, and thereby tending to reduce the curve. By resorting to this practice two or three times a day for a definite period, depending upon the nature and severity of the affection, much good may be obtained and very severe curvatures remedied. Cold sponge

or shower baths, if they can be borne, are always beneficial; so also is a moderately firm bed, a spring mattress being better than a feather bed. Gentle calisthenic exercises are valuable adjuncts to treatment when practised with discretion, and particularly the voluntary vertical extension of the patient's body by manual suspension from a bar or pulley; yet it should be remembered that a weak spine is being dealt with, and anything like violence may be very detrimental.

Should the curvature have been encouraged by any faulty habit, such as standing on one leg or in one position, or the use of one arm, it is almost needless to say that the habit should be discontinued.

The objects of treatment are, therefore, 1. To improve the general condition of the body; 2. To give rest to the strained and weakened muscles and ligaments; 3. To strengthen the muscles that support the spine by exercise carefully regulated, so as to prevent fatigue; 4. To restore the spine to its normal direction by posture, muscular extension, and by pressure applied in the horizontal position.

Mechanical contrivances have been much vaunted and are often employed. I confess, however, to having little faith in their value as *curative agents*. They tend to cause atrophy of the muscles that support the back instead of strengthening them, and thus to make the deformity permanent. In bad and exceptional cases they may, however, be employed when the treatment sketched out cannot be borne or is inapplicable. The best support is that of Sayre's or one of the felt jackets. When the deformity is irremediable and support essential to allow the patient to move about, an instrument is of great value.

It is probable that the deformity in its early stage chiefly arises from a compressed condition of the intervertebral substance, it being well known that this material is capable of being compressed one-fourth of its thickness. Hence a person by maintaining the erect posture during the day will be an inch shorter at night than in the morning. Any lateral curvature of the spine, however produced, unless remedied, will increase and be complicated with rotation. When unequal vertical compression is, therefore, kept up, the deformity produced by it becomes permanent, and the growing bones necessarily assume shapes and positions corresponding to the deformity and tending to increase it.

Organic Disease of the Spine and Angular Curvature.

This disease of the spine is due to a destructive inflammatory change of the bodies of the vertebra and intervertebral substances. It begins usually in the latter structure, although the bone itself may be its primary seat. It is at times associated with tubercular deposit in the tissue, though there is no evidence to prove that it is always due to the presence of tubercle. The curvature, generally known as "Pott's curvature," is directly due to the destruction of the bodies of the vertebræ and the intervening intervertebral substance, the upper vertebra falling down toward the lower and joining with it. When the bodies of many of the vertebræ are involved, the deformity will be severe; a preparation in Guy's Museum (1006^{50}. Fig. 96) shows the bodies of twelve vertebræ implicated, but a cure resulted. Paralysis may attend this affection, though it is rare to find the cord involved in the disease, even when the most destructive changes have taken place in the bones. Great deformity, even to an acute bending of the cord, may exist without giving rise to nervous complication (Fig. 97). The paralysis, too, may be lasting, but more commonly is only temporary. Angular curvature may occur at any period of life, but is more liable to appear during the growth and development of the spine, and consequently is more frequently found in childhood. From a remarkable preparation in the Guy's Hosp. Mus. (1004^{92}) it would seem

Fig. 96.

Angular Curvature of the Spine.

Fig. 97.

Angular Curvature of the Spine, the same as that Illustrated in Fig. 96. (Taken from a patient æt. 35.)

that it may attack the fœtus in utero and be repaired, the bodies of three or four of the dorsal vertebræ in this case being clearly fused together from disease, thus giving rise to angular curvature.

When a cure takes place, it is generally by anchylosis; occasionally, however, the parts are held together simply by fibrous tissue.

The disease more commonly attacks the lower dorsal region of the spine than any other, although the cervical and lumbar regions are not seldom implicated. In rare cases it attacks two different regions of the spine. It may run through its whole course, even to a cure, without giving rise to any external suppuration; more commonly, however, an abscess makes its appearance.

Spinal Abscess.—Pus will sometimes find its way from the dorsal region beneath the fascia that covers in the psoas muscle under Poupart's ligament, and then appear as a swelling in the groin at its inner half (*psoas abscess*). The swelling may burrow downward and involve the whole thigh in one large abscess. When the disease is in the lumbar region, pus may burrow between the dense layers of fasciæ that bind in the quadratus lumborum muscle and appear in the front of the abdomen above Poupart's ligament, and in rare cases pass down the inguinal canal and appear in the groin, simulating an inguinal hernia, or in the loin (*lumbar abscess*). In other cases it will make its way under the fascia that covers in the iliacus muscle and appear beneath Poupart's ligament, but at its outer half. In other instances, again, the matter will find a passage downward into the pelvis, and either make its way through the sciatic notch into the gluteal region (*gluteal abscess*) or pass downward behind the trochanter major to the thigh. In still rarer cases the pus appears by the side of the rectum.

When the cervical region is the seat of the disease, suppuration may appear in the pharynx as a *pharyngeal abscess*, or externally in the neck behind the sterno-cleido-mastoid muscle. The following case is a good example of this:

A boy æt. 3 was brought to me at Guy's in 1862 for some affection of his upper cervical vertebræ consequent on a fall down stairs upon his head. An abscess formed two months after the accident behind the left sterno-cleido-mastoid muscle, from which place a piece of the lamina of a vertebra escaped six months afterward. He kept his bed for upward of a year, when he got up with a stiff neck. He was unable to nod or rotate the the head, clearly showing that the joints between the occipital bone and the first two vertebræ had been diseased and become anchylosed. In 1867 this boy again came under my notice. His head was quite fixed; the cervical vertebræ seemed shorter than usual, but no irregularity existed.

The annexed drawings (Figs. 98, 99, 100), taken from Ellen T——, æt. 14, a patient of Mr. Poland's, illustrate a severe case of cervical disease with lateral deformity. In this

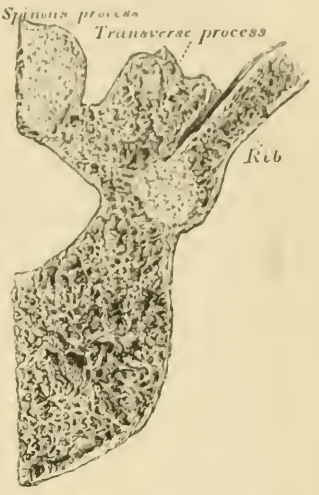
Fig. 98. Fig. 99. Fig. 100.

patient a good result was obtained by means of the apparatus depicted in Fig. 100, the cure resulting in anchylosis.

Exfoliation of Bone.—From any of these abscesses bone may exfoliate, and it may be coughed up from the pharynx or discharged through the neck. I have seen a mass of bone the size of a nut come away from a lumbar abscess, and a piece of bone clearly spinal discharged from an abscess of the thigh, opening above the knee-joint. In a case brought under my notice by a valued dresser, Mr. Burgess, the anterior half of the atlas, with its articular facets, was expectorated, recovery ensuing, the man being well eight years subsequently; and in Guy's Hosp. Museum (prep. 1018[15]) there is a preparation of the odontoid process which a woman who had had a stiff neck for months coughed up, and from which complete recovery ensued. Mr. Keate so long ago as 1835 recorded

(*Med. Gaz.*) a case in which the anterior half of the atlas exfoliated, and Mr. Collis in his book on *Syphilis*, and Mr. Coppinger of Dublin, in the *Dublin Journ.*, December, 1879, have both published instances in which the corresponding portion of bone exfoliated. In fact, from all these *spinal abscesses* bone may be discharged, and, what is more, recovery follow.

Fig. 101.



Synostosis of Ribs to Vertebræ, etc.

Anchylosis without Suppuration.—Suppuration, however, does not always take place. A woman æt. 30 came under my care in 1859 for a stiffness of her head and neck that had been increasing for two years, and which she regarded as rheumatic. When I saw her, the head was immovably fixed and slightly rotated to the right side. Rotation and nodding were impossible. There was much thickening about the cervical vertebræ, with pains darting upward to the vertex and downward to the shoulder. By rest in bed, fomentations, and tonics all these disappeared and recovery ensued, but with a stiff neck. My colleague, Dr. Fagge, has also recorded in the *Path. Soc. Trans.* for 1877 a remarkable case of synostosis of the arches of the vertebræ, of the ribs to the vertebræ, and of the hip-joint, in which a bending of the dorsal vertebræ forward with immobility were the only symptoms of spinal disease that existed during life (Fig. 101). It occurred in a man æt. 34, who died with inflammation and dilatation of the bronchial tubes from asphyxia, his breathing having been entirely diaphragmatic from a want of movement in the costal joints.

Diagnosis.—When an angular curvature of the spine exists, there can be no difficulty in recognizing the nature of the disease or the process by which the curvature has been brought about. When a large abscess coexists with the deformity, there is good reason to suspect that the one is the direct result of the other, more particularly when the suppuration can be traced up to the spinal deformity. But in the early stage of the disease the diagnosis is not so easy, and yet it is here that a correct one is most needed; for if any decided good is to be gained by treatment, it is at this early period. What, then, are the indications which denote the presence of incipient spinal disease? *Local and persistent pain* is probably the earliest; and when this is accompanied by *local tenderness* on firm pressure and pain is experienced in the distribution of any of the nerves coming from the seat of the affection, as over the shoulders and down the arms in lower cervical disease, around the abdomen and above the umbilicus in upper dorsal, and below the umbilicus and down the thighs in lumbar disease, the surgeon's suspicions should be excited. When the patient complains of any sudden jar of the back by a slip down stairs or by any jump, when added to these symptoms he exhibits extreme caution and a *rigidity of the spine* in walking or moving, and when, on being told to pick up anything from the ground, *he bends his knees in preference to bending his back* (Fig. 102), and when, moreover, he rolls off a couch instead of rising up boldly from the recumbent posture, and supports his body, when standing, with his hands either upon his thighs or neighboring piece of furniture (Fig. 103), the diagnosis becomes certain. When, moreover, coughing or sneezing excites pain, and last, but not least, when any constitutional disturbance is present, such as a quick pulse, occasional febrility, and a furred tongue,—when all these symptoms, or many in combination, exist during that period of life when bones are growing and bone disease is apt to appear, the surgeon should always suspect disease of some portion of the spine, and until he can satisfy himself that none such exists it is a wise plan to treat the case as if it were pres-

Fig. 102.

Fig. 103.

ent. It is true that by adopting this rule of practice he will be occasionally misled and at times treat a case of hysteria as one of spinal disease, but then what harm? He will probably do good to the hysterical patient by the treatment he would adopt for the spinal complaint, while he would certainly do much harm to the latter by neglecting such measures as are essential for its successful treatment.

TREATMENT.—It is an interesting clinical fact that the best cases of recovery from the worst examples of spinal curvature and disease are to be found amongst that miserable class of patients who have never had any chance of receiving proper treatment, who have never had rest or any care, in whom the disease has run its course untended and uncared for, and yet in whom a cure has taken place with firm anchylosis, although with deformity. The majority of these cases are examples of disease of the dorsal vertebræ. How far this deformity might have been lessened or prevented by proper treatment is an open question. Nevertheless, it is beyond all doubt that in the early stage of this disease immobility of the spine, rigidly and persistently maintained, and the removal of downward pressure upon the vertebræ, are absolutely essential points of practice to be observed. Not, however, rest upon the back, for in many instances this supine position tends rather to separate parts that ought to be kept in contact, but rest in any position, prone or supine, the patient feels to be most comfortable.

The general health of the patient must be maintained as much as possible by simple nutritious food, stimulants enough to assist digestion and no more, with tonics, such as iron, quinine, and cod-liver oil.

When pain exists, local fomentations are often a comfort; occasionally, too, the application of a few leeches relieves. Small flying blisters placed alternately on either side of the painful spot are sometimes of use, and a plaster of belladonna or opium rubbed down with glycerine over the part is a valuable adjunct. When severe nerve pain is present, the hypodermic injection of morphia may be used. Sedatives must be given to induce sleep when it cannot otherwise be obtained. Setons, moxas, and mercury are not to be recommended.

By the adoption of this line of treatment a cure may be obtained. It must, however, be followed out for months, and even years, the greatest care being taken that the patient is not released too soon, for a relapse is always a very serious affair.

Dr. Lewis A. Sayre's plaster-of-Paris jacket appears to me to be the best kind of apparatus, for it is simple, economical, easily applied, and efficient, securing absolute immobility of the spine and at the same time giving comfort to the wearer. It can be readily applied by any medical practitioner with little expense, and does not debar the patient from the benefit of fresh air and change of scene.

The body of the patient to whom it is to be applied is first to be covered with a thick closely-woven merino shirt, which is to be fastened above over the shoulders and below between the thighs; in a female over a handkerchief. A pad, which Sayre calls a dinner pad, made of cotton-wool, folded in a handkerchief so as to form a wedge-shaped mass with the thin edge downward, is then to be introduced beneath this shirt over the region of the stomach, of sufficient size to supply, when it is removed, a space which will permit of distension of the abdominal parietes. All projecting spinous processes of vertebræ are to be protected from pressure by the application on either side of them of a strip of thick felt plaster. The patient is then to be supported by straps carefully adjusted to the axillæ, symphysis mentis, and occiput (Fig. 104), attached to the extremities of a cross bar which may be suspended from a hook fastened to a beam or high door by a compound pulley, the body being sufficiently suspended to allow of its weight serving as an extending force, but *always within the limit of pain*. Elevation of the heels is enough for the purpose. The trunk is then to be carefully encased from below the crests of the ilia upward to the axillæ by the rapid application of coarse muslin or crinoline bandages, 2½ inches wide, into which *dry freshly-ground* plaster-of-Paris has been rubbed, the bandages just before they are used being placed vertically in tepid water deep enough to cover them and left a sufficient time to allow all bubbles to escape. The bandages should be well squeezed before they are rolled round the body, and in their application care should be taken to see that they are applied flat, without making any traction, and well smoothed down. It is well also during this process to wet the jacket with water and rub in more plaster.

The patient should be laid down in the recumbent position upon a mattress before the plaster is quite set, the dinner pad removed, and the casing slightly flattened in front of the anterior superior spinous processes of the ilium, to guard against pressure. The merino jacket may then be unfastened beneath the thighs and above the shoulders and

turned at both ends over the casing, the ends being fastened down by a few extra turns of the plaster bandage.

In the course of a fortnight, if all things go on well and no evidence of undue pressure in any part exists, the casing may be split up along the front, its edges bound, eyelets

Fig. 105. Fig. 104.

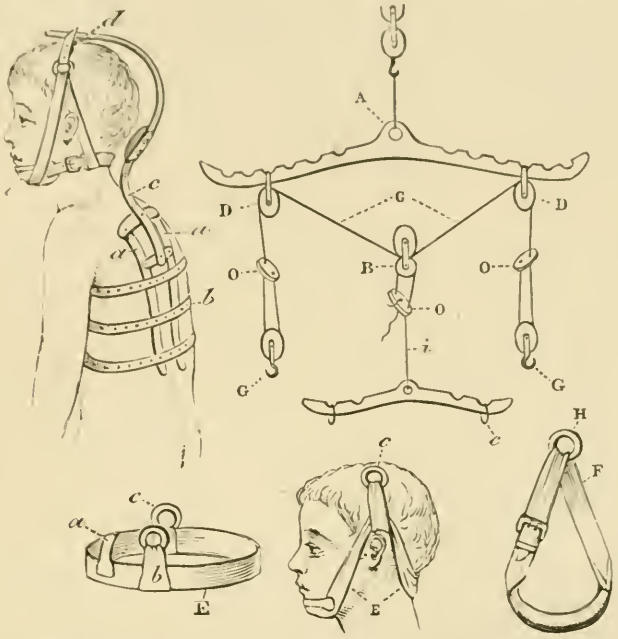


Fig. 104.—Description of Sayre's Apparatus as improved by Golding Bird, by which the drag on the arms and head can be varied by altering the relative length of cords I and G. The smaller the angle at G, the more the drag on the head, and *vice versâ*.

A Cross-bar suspended by running tackle to Sayre's tripod or to hook secured to cross-beam of a folding-door. B. Pulley acting upon central bar, to the end of which are suspended the iron rings *c*, attached to the head-piece, E. D. Pulleys connected with arm suspender, F, by hook G, and H, ring, worked by running cord 36 inches long, which can be lengthened at will and fastened by cleats, O. E. Head-piece made of 2-inch worsted webbing sewn into a circle 27½ inches for adult, 23 inches for children, with (*a*) chin-piece made of wash leather, and (*b*) two circular sliders of same web, 6 inches round, attached to iron rings, *c*. The sliders, by being slid forward or backward, can be made to pull more or less against the chin or occiput. F. Arm-pieces made of 2-inch cotton-web 1 yard round, capable of being shortened by buckle. They are softly padded with horsehair in the middle and covered with wash leather; each carries an iron ring, H. On first suspending a patient the running cord, G, should be at its shortest, the centre cord, *i*, at its longest.

Fig. 105. Sayre's Jury-Mast Apparatus—*a*. Two pieces of malleable iron bent to fit the curve of the back. *b*. Three or more roughened strips of tin attached to iron, long enough to encircle the body. *c*. Central shaft carried in a curve over the top of the head and capable of being elongated at will, springing from cross-pieces of *a*. *d*. Swivel cross-bar with hooks attached to end of *c*, from which straps depend to support head and chin collar, *e*. This apparatus is applied over the jacket with a plaster bandage.

introduced, and a lace inserted, in order that it may at times be removed for personal cleanliness and comfort and reapplied. The jacket should be worn so long as it is easy; and when worn out, another should be substituted.

When the cervical or upper dorsal region is diseased, a vertical splint, Sayre's jury-mast apparatus (Fig. 105), to take off pressure of the head and prevent rotation, will be required.

When this splint is used for lateral curvatures, the patient should suspend himself by his arms.

In female patients a pad should be placed over each breast and removed with the dinner pad just before the plaster sets. Smaller pads may likewise be placed over the anterior iliac spines. "When the disease is situated in the dorsal region, the jacket should not be opened, for the reason that if the respiratory movements of the chest are permitted to go on without restraint the heads of the ribs will necessarily move freely and the disease will be increased rather than diminished. But if the ribs be held still and the diaphragm thus made to act more fully, the breathing, instead of being thoracic, is rendered diaphragmatic and abdominal, and all the short, grunting, catching respiration ceases."

Caution.—In *acute* or progressive disease suspension is dangerous, and vertical

extension is to be applied with the greatest caution. Immobility of the spine is the essential object to secure.

Treatment.—*Spinal abscesses* should not be opened hastily, inasmuch as they may become absorbed and wither away. When steadily progressing, however, they must be dealt with, and a good method without doubt is to make a free opening under a piece of lint saturated with oil, carbolized or not. I have, however, in recent years made a free opening into the abscess without any such precautions, washed out the abscess cavity with iodine water, boracic acid, or chloride of zinc lotion two grains to the ounce, with equally good results, making the opening so free that no pus could be retained; and if air got in, it as freely got out again. In all cases a drainage tube should be introduced and the cavity kept empty and clean by repeated irrigation. Retained pus and air are sure to decompose; but if a free vent be made for both, harm rarely ensues. To allow abscesses to enlarge to any extent without interfering is not good surgery, as the amount of constitutional disturbance that follows the opening of an abscess is closely proportioned to its size, and a large abscess cavity secretes more pus than a small one. It is true that after the opening of a chronic abscess a patient who may have been fairly well becomes feverish, and possibly exhausted by hectic; but it should be remembered that by delay the abscess will become larger, and the constitutional disturbance as a consequence more severe, when the opening has taken place.

Disease of the Upper Cervical Vertebræ.—Disease of the upper two cervical vertebræ and of the occipital articulation is often found, and may be accounted for by the greater mobility of the joints, and consequent liability of the ligaments to sprain and laceration. Disease may be situated in the bones entering into the formation of the joints or in the soft parts binding them together, and with the disease some displacement of one of the vertebræ is occasionally met with. When the disease is in the second vertebra, the odontoid process may separate, and even exfoliate.

When the transverse ligament is diseased, the odontoid process may become displaced and the cord injured (Guy's Museum, Prep. 1289[32]). When the displacement is great, sudden death may take place under these circumstances; and when partial, more or less paralysis may ensue, according to the amount of pressure the cord has sustained. Fixed pain about the cervical vertebræ, with pain in the occipital region, in the distribution of the occipital nerves, and stiff neck, is always suspicious of cervical disease; and when to this is added a disinclination to rotate the head and a preference to rotate the body instead, when the chin is tilted up and a modified form of opisthotonos exists or there is slight torticollis, when the patient supports the chin with his hand to prevent it falling forward on the sternum, and when pain is aggravated by rotation or downward pressure of the head, the case is serious and the diagnosis clear.

Treatment must be conducted on recognized principles. The danger of sudden death by the displacement of the bones must be diminished by the application of a support to keep the head straight and prevent its falling forward, and this may be accomplished by the application of a collar round the neck, passing under the chin with a support embracing the head, an inflating rubber collar being by far the best, or by Sayre's jury-mast apparatus (Fig. 105). Rest in the horizontal position, is, however, of greater value, care being observed to keep a small firm pillow underneath the neck to preserve the hollow, and in this way, as pointed out by Hilton in his classical work *On Rest*, "to lift up the body of the second vertebra and remove the odontoid process from the lower part of the medulla oblongata, and thus prevent the fatal results of pressure upon it." At the same time, the head should be kept at rest by means of sand-bags applied laterally. Remedies that have been mentioned in the treatment of angular curvature of the spine are here of use. In cases of severe spinal curvature there is good reason to believe that the span of life is often shortened on account of the interference with the respiratory and circulatory functions caused by the deformity. My colleague, Dr. Fagge, has written an interesting paper on this subject (*Guy's Hosp. Rep.*, 1874).

INJURIES AND DISEASES OF THE NERVES.

When a nerve is struck or contused, pain is produced; and it may be of a passing tingling character or of a far more severe kind. Most people are rendered familiar with these facts by an occasional blow upon the ulnar nerve, or what is called the "funny bone." When the blow has been severe, the pain may be lasting and the functions of the nerve so disturbed or interfered with as to give rise to loss of power or sensation in the parts supplied by the injured nerve. A man æt. 29 went to sleep with his elbow resting

on a table; and when he awoke, there was complete paralysis both of motion and sensation of the parts supplied by the ulnar nerve. When I saw him, two days afterward, these symptoms were very marked; there was also tenderness over the nerve behind the inner condyle, to which spot a blister was applied. In a fortnight returning sensation appeared, with some slight power of motion, and in five weeks he was well. This was clearly a case of paralysis of a nerve from contusion. A man æt. 46 received a blow upon his ulnar nerve against a chair. No pain appeared at the time, but three hours later pain and numbness showed themselves, and at this time some thickening over the spot could be made out. In the course of three weeks these symptoms disappeared and recovery was complete. In this case it would appear as if some hemorrhage had taken place into the nerve sheath, giving rise to the paralysis, which disappeared as the blood was absorbed.

Wounds of Nerves.

When a nerve is *wounded*, pain is produced; and this may be of a passing or more permanent character. In nervous, hysterical subjects the nerve pain is sometimes severe and persistent, and is then called "neuralgia." It may be confined to a branch of the injured nerve or it may involve the whole trunk.

When a nerve is *divided*, complete paralysis of the parts supplied by it follows. It may, however, reunite and recover its functions. Paget has related a case of complete division of the median nerve in which the trunk had nearly recovered its conducting power a month after the wound. I have seen a similar case in which recovery ensued in four months. The following is another example in point: A woman æt. 30 came to me with an incised wound behind the inner condyle of the humerus. The ulnar nerve had been divided, and there was complete paralysis of motion and sensation of the parts supplied by it. The edges of the wound were adjusted and the arm placed in a sling. A month later she returned with a burning pain in the little finger, which was really cold, but red, swollen, shining, and blistered; and when touched, some slight sensation was produced. Cotton-wool and oiled lint were applied, and the arm was fixed upon a straight splint. The original wound had nearly healed. In two weeks the finger looked natural; sensation in it and all other parts supplied by the nerve had improved. In another month she returned with the old symptoms as bad as ever. They had reappeared upon the removal of the splint two weeks previously, but on its reapplication with the cotton-wool they again disappeared. The splint was then kept on for two months, when sensation became natural, complete repair having taken place in four months. When seen six months later, she was still well.

The red, swollen, shining, and blistered condition of a finger deprived of nerve force is characteristic, and is generally associated with the sensation of a burning pain and loss of temperature, amounting sometimes to a depression of 9° or 10° Fahr. There may likewise be a curving of the nails, as seen in phthisis, or ulceration of their roots. These symptoms are clearly due to malnutrition. When the nerve repair does not take place, these symptoms are very apt to return from time to time on any change of temperature or depression of the general power of the patient.

Joint Affections.—The *joints of limbs* in which the nerve supply has been interfered with, after injury undergo a change which consists essentially in a painful swelling of these joints, which may attack any or all of the articulations of a member. It is, says Mitchell, distinct from the early swelling due to the inflammation about the wound itself, although it may be masked by it for a time; nor is it merely part of the general œdema which is a common consequence of wounds. It is more than these—more important, more persistent. Once fully established, it keeps the joints stiff and sore for weeks or months. When the acute stage has departed, the tissues about the articulations become hard and partial anchylosis results; so that in many cases the only final cause of loss of motion is due to this state of the joints (*War of Rebellion*, part iii., vol. 2, p. 745). When the ulnar nerve is completely paralyzed—in which case atrophy of the muscles supplied by it ensues—the aspect of the hand is very characteristic, the wasting of the interosseous muscles, with the abductor indicis (also an interosseous), and all those of the little fingers, giving rise to a peculiar hollowing of the parts between the metacarpal bones which is typical. Nerves when divided do not, however, always reunite. When a piece has been removed either by accident or by design, as in the operation for tic douloureux, the restoration of function is very rare, though it may occur.

Treatment.—Bruised nerves are to be left alone, natural processes being, as a rule,

amply sufficient to effect a cure. When recovery is slow and associated with pain in the injured part, the application of a small blister is beneficial. Divided nerve should always be brought together by sutures and the limb placed in the best position to prevent any separation of the divided ends: the paralyzed parts should be kept warm with cotton-wool and of an equable temperature, and the whole limb at rest, until complete repair has taken place. Even after a nerve has been divided for some weeks there is a good prospect of the divided ends uniting on their readjustment by sutures after fresh transverse sections have been made of the separated ends (*vide* Hulke, *Clin. Soc. Trans.*, vol. xii.). Mr. Favell of Sheffield has recently published some good cases in favor of the practice,[1] and Dr. Weir Mitchell[2] has shown that in one hundred and twenty cases of nerve section regeneration of nerve took place in most in about six months. When much pain exists, belladonna or opium rubbed down with glycerine is a nice application, and the hypodermic injection of morphia is often of much value. The application of a suture to a divided nerve is not, however, uniformly successful.

Neuralgia, Tic Douloureux.

The subject of neuralgia belongs more properly to the physician than to the surgeon, yet the latter is often called upon to consider cases of this nature. The first point to determine is whether the pain is due to any local cause, and if so, to remove it. Thus a decayed tooth too often is the cause of pain in the course of branches of the fifth nerve, although the tooth may have neither ached nor exhibited any external evidence of decay. The pressure of a small tumor on a nerve, some irregularity in the bone, or a cicatrix involving a nerve are causes which sometimes require the surgeon's interference to effect a cure. The following example illustrates these remarks: A man æt. 41 came under my care in 1866 for severe pain down the anterior and outer portion of his left leg and foot, with almost complete paralysis of the extensor muscles. The symptoms had been coming on gradually for years, and had followed a severe wound sustained twelve years previously over the head of the fibula. There was a hard cicatrix over the head of the fibula which clearly involved the external popliteal nerve. I made two deep vertical incisions on either side of the cicatrix, by this means taking tension off the nerve and affording complete relief; six weeks later he was still well. Whenever neuralgic pain is associated with a cancerous tumor or comes on after its removal, the surgeon should suspect the existence of some secondary cancerous deposit in the course of the sensory nerve.

The great majority of cases of neuralgia, however, have a constitutional origin, and their cause is to be found in some hereditary tendency, in depression, anxiety, or some obvious derangement of health such as is expressed by the term "anæmia." Many, too, have a malarious origin and depend on climatic influences, such as residence in a damp or wet place. The disease known as "tic douloureux" is an affection of the fifth nerve and its branches, but any nerve in the body is liable to suffer. The pain is often very intense, and recurs in paroxysms at certain hours or on exposure to draught or cold.

Treatment.—The treatment of these cases of neuralgia must be regulated entirely by their cause. When a local cause can be made out, its removal is the only remedy—for example, the removal of a tooth, of a tumor, or of a bulbous extremity of a nerve. When hysteria complicates the case, or any uterine disturbance, tonics are suggested, such as iron, zinc, or quinine, and of these full doses may be given. When malaria appears to be the cause, bark or quinine is invaluable. In all forms of local neuralgia, more particularly in *sciatica*, the hypodermic injection of morphia in one-third or half-grain doses, injected in the course of the nerve, often acts as a charm. Chloroform, belladonna, and opium, locally applied, are also valuable. The general condition of the patient should always be attended to and the treatment directed to its improvement. Good food, fresh air, and tonics are always essentials. Purgatives are seldom necessary, and must be regulated so as not to depress. Stimulants, but not in excess, are of great use. In females the condition of the uterine organs should always be carefully attended to.

Division of Nerve.—In obstinate cases of neuralgia the division of the nerve has been performed with occasional success. It is not, however, an operation in favor of which much can be said. When the cause of the neuralgia is peripheral, it may succeed for a time, but in these cases spontaneous recovery is not unusual; and when some cen-

[1] "Address on Surgery," *Brit. Med. Journ.*, Aug. 5, 1876.
[2] *Amer. Journ. of Med. Sci.*, April, 1876.

tral mischief is the source of the pain, the operation is not likely to be of service. Nevertheless, in desperate cases the excision of a portion of the offending nerve is a justifiable operation; it has been of use, and may be so again. Sir J. Fayrer has related in the *Med. Times* for 1860 a case of sciatica in a syphilitic man, æt. 30, in whom swelling was detected in the nerve sheath, and pain was at once relieved by puncturing the part with a knife.

As much may likewise be said for nerve-stretching, which is to be preferred.

Neuroma.

Any tumor connected with a nerve is called a "neuroma." These neuromata may be of a fibrous or of a fibro-cellular kind, and there is reason to believe that they have an inflammatory origin. They may be very small or of large dimensions; and when large, they may contain cysts. Sometimes they are developed *within* the nerve sheath; at others they are situated *upon* it. In a third class the fibrillæ of the nerve trunk appear to be separated by the new tissue or to become incorporated with the growth. They are at times single, but more frequently multiple, and occasionally involve nearly every cerebro-spinal nerve in the body. Wilks has recorded such a case in the *Path. Soc. Trans.*, vol. x., in which after death neuromata were found all over the body, appearing as nodules on some nerves and as distinct tumors on others; the nerves appeared of irregular size and were indurated, the fibrous tissue being infiltrated among the nerve fibres. The pneumogastric nerve had a tumor the size of an egg upon it. Dr. Smith of Dublin, in his unrivalled monograph on the subject, has recorded an instance in which many hundreds of such tumors existed; other similar cases might be quoted.

Symptoms.—These tumors are not painful, as a rule: indeed, in the most marked examples of this disease, in which the tumors are multiple, they are often not recognizable till after death. Pain, however, is sometimes present, aggravated on pressure and apparently depending much upon the mode in which the nerve is involved. The affection is not to be confounded with the *painful subcutaneous tumor*.

When the ends of a divided nerve become bulbous from fibrinous effusion, what is called a *traumatic neuroma* is formed. When this becomes involved in the cicatrix of a stump, it is an exceedingly painful affection, and is thought by some surgeons to be more common after flap amputations than others. It must be remembered, however, that all nerve trunks become more or less bulbous after amputation.

Treatment.—There is no reason why neuromata should be removed or touched unless they are large or painful. When from these causes they require treatment, the operation should be performed, care being observed to dissect the tumor from the nerve when it is possible, which, however, can rarely be done. In 1882 I removed a cystic tumor the size of a large nut with permanent success from the upper cord of the left brachial plexus of a lady-patient of mine who had suffered continual agonies of pain down the arm: the cyst was in the nerve cord itself. I have removed others from the median and sciatic. In the former case the tumor had been treated by another surgeon as a ganglion and punctured. Many cases are on record in which large neuromata have been excised with the nerve trunk and a good recovery has followed, even with a restoration of the functions of the divided nerve. Traumatic neuromata should always be excised when causing much pain; but when associated with symptoms of spinal irritation, which may possibly be due to a neuritis travelling up the affected nerve trunk, the forcible stretching of the nerve, as recommended by Billroth and Nussbaum and practised by others, should be employed.

On Nerve-Stretching.

In 1869, Billroth cut down upon the sciatic nerve with the view of removing a neuroma, and, though no tumor was found, the manipulation and stretching of the nerve brought, unexpectedly, permanent relief to the pain the patient had experienced. Three years later (February, 1872) Nussbaum of Münich cut down upon the brachial plexus to stretch some of its trunks for painful spasmodic contraction of the flexors of the arm and hand, and the operation was successful.

Since these early operations of nerve-stretching many have been undertaken with very variable success.

It would seem from the excellent papers noted[1] that when a nerve is stretched

[1] *Revue de Chirurgie*, 1882, Paris; *Med. Rec.*, New York, September, 1882.

extravasation of blood takes place within its sheath above and below the point of traction where the vessels from the nerves penetrate the sheath, and that these extravasations entirely disappear in about five or six weeks; that embryonic cells under the sheath and wasting of the superficial nerve-fascicles with some segmentation of the nerve cells are found; that if the nerve be drawn away *from* the spinal cord anæsthesia with slight paresis follows, but if *toward* the cord the paresis is increased and there may be a loss of reflexes.

There is also evidence to show that the stretching may produce some change in the nerve centres themselves, as indicated by more or less persistent modifications of function of different parts of the body.

In seventy operations for sciatica statistics indicate that in sixty the patient was either cured or greatly relieved, and that in the majority of cases the relief was permanent.

In thirty-seven operations on the fifth pair of nerves success was reported in twenty-nine, and that in traumatic neuralgia the success was equally good.

Nerve-stretching for locomotor ataxia has been attempted in fifty-seven cases, and in sixteen with decided success. It has likewise been employed for traumatic tetanus in fifty cases, with ten recoveries.

Langenbeck states very decidedly that it is better to stretch the sciatic nerve in its middle or lower third below its muscular branches, there being thus less risk of the operation being followed by atrophy of the limbs.

The dangers of the measure are such as attend all operations. It is, consequently, an operative proceeding of a justifiable kind, but one that requires caution in its application.

The operation consists in the free exposure of the nerve trunk by incision and the application of forcible traction to it, both proximally and distally. The traction has been great, as one author, in describing the operation as applied to the sciatic nerve, says that "the limb of the patient should be lifted from the table by the sciatic nerve." This is probably unnecessary, but under all circumstances the stretching should be enough to destroy the sensibility of the nerve for some days.

Painful Subcutaneous Tumors.

These tumors are clinically to be separated from the neuromata, which have just been considered, although they have often doubtless been confused with them. They are not, however, nerve tumors. They were first described by Wood in the *Edinburgh Medical Journal* for 1812. They are usually single and situated in the subcutaneous tissue, and are rarely larger than a small bean. They are encysted and give to the finger a hard elastic touch. To the eye they appear bright yellowish or a pearly white, and are made up of fibro-cellular or fibrous tissue.[1] *Intense painfulness* is their clinical peculiarity, although they have no such nerve connection as will explain their excessive sensibility. The pain, says Sir J. Paget, is of the nature of that morbid state of nerve force which we call neuralgia.

The painful character of these tumors is very peculiar. It is not constant, nor does it appear to depend upon any injury, and sometimes comes on without any assignable cause or after only the slightest touch, the pain beginning in the tumor, gradually increasing in intensity and extent till it becomes almost unendurable, darting from the tumor up and down the limb or over the body. The muscles of the limb may likewise be spasmodically affected. The paroxysm may last only a few minutes or may continue for hours, and subsides, as it appears, gradually, leaving the parts tender that were the seat of pain. These painful tumors are most frequent in the female, the neuromata more frequent in the male.

Treatment.—The only treatment is the excision of the growth, which is generally effectual. These tumors rarely recur, although Sir J. Paget has recorded one or two examples of recurrence.

[1] *Revue de Chirurgie*, 1872, Paris.

CHAPTER VIII.

DISEASES AND INJURIES OF THE EYE, ETC.

By CHARLES HIGGINS.

EXAMINATION OF THE EYEBALL AND ITS APPENDAGES.

The examination of the eyeball will be considered under four heads:

1st. By the unaided eye.
2d. By lateral illumination.
3d. By the ophthalmoscope.
  (*a*) Direct examination.
  (*b*) Indirect examination.
4th. By manipulation.

The *refraction* of the eyeball, the field of vision, etc., will also receive a short notice.

I. Examination by the Unaided Eye.

In order to examine the outer surface of the eyelids, ocular conjunctiva, cornea, anterior portion of sclerotic, aqueous chamber, and lachrymal apparatus, it is necessary to place the patient in a good light (as before a window) and direct him at first to close the eyes, then open them widely and look by turns in different directions.

To examine the palpebral conjunctiva it is necessary to evert the upper lid and to draw the lower one downward. Eversion of the upper lid can be accomplished thus: The surgeon, standing in front of the patient, should direct him to look downward and close the eyes; he should then place the forefinger of one hand upon the lid at the attached or upper border of the tarsal cartilage and make gentle pressure downward and backward, so as to cause the free edge of the lid to stand away from the eyeball, then place his thumb beneath the margin of the lid and make a slight upward movement, at the same time continuing the pressure with the finger; by this means the lid will be made to turn upon itself and become everted. The lid may also be everted by pressing a probe horizontally upon its outer surface and drawing it upward by means of the lashes, at the same time making pressure downward with the probe.

To examine the conjunctiva covering the lower lid, all that is necessary is to place the finger upon the margin of the lid and draw it strongly downward, when its conjunctival surface will become exposed.

Normal Appearances.

The outer surface of the eyelids is covered by soft, delicate skin, which is thrown into folds on every contraction of the orbicularis; their free margins are of some thickness. From the outer edge of this free margin project the lashes in two or three rows, those of the upper lid being thicker and longer than those of the lower. The lashes extend along the whole outer edge of each lid, but are much fewer and more delicate in that portion extending from the tear punctum to the inner canthus.

The inner edge of each margin is occupied by the orifices of the Meibomian glands, which are seen as a close set of yellowish points.

The ocular conjunctiva is smooth, moist, shining, and transparent, allowing the white sclerotic to show plainly through it; a few vessels are generally seen running from the outer and inner canthi toward the cornea, but these are perfectly consistent with a healthy condition of the membrane. The caruncle and semilunar fold occupy the space immediately external to the inner canthus, the former appearing as a small reddish-gray projection, the latter as a well-defined pinkish fold. *The palpebral conjunctiva* is also smooth, moist, shining, and transparent, and appears to have somewhat of a yellowish color, from the tarsal cartilage, to which it is closely and evenly united, showing through it. That portion of conjunctiva reflected from the lids to the globe (*fornix*) appears somewhat thickened and wrinkled and is slightly more vascular than the ocular and palpebral portions.

Parts requiring Special Notice.—Certain parts of the conjunctiva require to

be specially examined. The portions next the thickened margin of the lid, the fornix, and about the caruncle are the most likely situations for the lodgment of a foreign body. That portion covering the attached border of the tarsal cartilage also should be noticed, as it is here that granular ophthalmia manifests itself most plainly.

The cornea is smooth, shining, and perfectly transparent throughout, except in the case of old people, in whom a bluish-white rim (arcus senilis) is often seen occupying more or less of the structure, somewhat within its margin; no blood vessels are seen on its surface or in its substance.

The anterior portion of the sclerotic is pearly white or of a pale bluish tint and shining. It is plainly visible through the transparent conjunctiva covering it; some fine vascular twigs may occasionally be seen traversing it in front of its equatorial region. The aqueous chamber is filled by the aqueous humor, which is transparent, colorless, and of such quantity as to preserve the proper curvature of the cornea without causing tension or allowing of laxity, and to keep it separated from the iris by a considerable interval.

The iris varies in color in different individuals; it is bright, shining, and marked by slight radiating ridges around the pupil; it presents in health no appearance of blood vessels. Its plane is exactly vertical; the pupil, situated somewhat to the inner side of the centre of the iris, is perfectly circular and dilates and contracts quickly with variations of light.

The examination of the *lachrymal apparatus* gives chiefly negative results; the position of the tear puncta closely in contact with the ocular conjunctiva must be noticed; pressure with the finger over the lachrymal sac causes no escape of fluid through the puncta, neither can the lachrymal gland be felt or seen in a normal condition of the parts.

II. Examination by Lateral Illumination.

By this method all the parts mentioned above are seen more clearly; minute foreign bodies, slight opacities of the cornea, etc., which might be overlooked in examining with the unaided eye, are discovered, and in addition the whole of the lens and the anterior portion of the vitreous can most satisfactorily be looked into.

The method of examination should be as follows: The patient should be seated in a dark room (the pupil having been previously dilated with atropine) and a lamp placed at about two feet distance on the left and rather in front of his face. The surgeon should stand nearly in front, or rather to the patient's right side, and facing him; he should then take in his right hand a bi-convex lens of about 2½ inches' focal length,[1] and with it concentrate the light on the surface of the cornea; with a little manœuvring he will find that he can throw the light through the pupil to a considerable depth into the eye. The patient should be told to look in various directions, so that all parts of the anterior portion of the eye may be examined.

Results Obtained.—The results obtained by lateral illumination are chiefly negative. The lens in health is perfectly transparent and in youth is nearly colorless, but some bluish lines showing its division into different segments can be recognized by careful examination. As age advances these lines become more marked and the whole lens appears of a bluish-gray color, though its transparency is still unaffected.

Behind the lens all appears dark, but any tumor, hemorrhage, etc., occupying the anterior part of the vitreous would be discovered.

It should be noticed in the examination by lateral illumination that opacities of the cornea, etc., always appear with greatest distinctness on the side which is farthest from the light. A second lens may also be used to magnify the parts illuminated by means of the first.

III. Examination by the Ophthalmoscope.

Description of the Instrument.—The ophthalmoscope, as used at the present day, consists essentially of a mirror of silvered glass or polished metal having a central opening, with certain accessory portions in the shape of convex lenses of different foci, used as objective lenses, clips and other contrivances for holding ocular lenses behind the sight-hole of the ophthalmoscope, together with the ocular lenses themselves. The ophthalmoscope since its introduction has undergone innumerable modifications, both in principle and detail, the number of different instruments now in use being nearly or quite as great as that of ophthalmic surgeons.

[1] A lens of 2½ inches' focal length is about equal to one of sixteen dioptrics in the metrical system.

The most useful form of ophthalmoscope is that of Liebreich; the latest modification (Fig. 106) of this instrument consists of a silvered glass concave mirror of about 8 inches' focal length, having a central opening in the silvering of a line and a half diameter. The mirror is fixed in a metal back, having a central perforation about double the diameter of the opening in the silvering. Upon the metal back is fixed a clip for the purpose of holding an ocular lens; the back is screwed to a handle about 2½ inches long. The accessory portions consist of two object lenses of 2½ and 3 inches' focal length respectively,[1] and five ocular lenses—two convex, of 6 and 12 inches positive foci;[2] three concave, of 8, 12, and 24 inches negative foci;[3] all are made to fit into the above-mentioned clip. A very convenient case contains the whole.

Method of Using the Ophthalmoscope.—There are two methods of using this instrument. The first, which requires much practice, is called the direct method of examination, or examination of the *erect image*, with the ophthalmoscope alone, without the aid of a bi-convex object lens.

The second, which is much the easier of the two, is called the indirect method, or examination of *the inverted image;* in it both the ophthalmoscope and a bi-convex lens are used.

Direct Ophthalmoscopic Examination.—In this method a virtual erect image situated behind the eye is seen. The examination is conducted in the following manner:

The patient being seated in a dark room, a gas or other lamp (gas being preferable) should be placed at the side corresponding to the examined eye, on a level with it, but so situated as to leave the cornea in shade; he should then be directed to look forward and a little upward, at some distant object, and to keep the eyes as steady as possible.

Fig. 106.

Liebreich's Ophthalmoscope.

Supposing the right eye to be examined, the lamp should be placed at the patient's right side; the observer, standing in front at a distance of 18 inches or 2 feet, should take the ophthalmoscope in his right hand, look through the sight-hole with the right eye, and reflect the light from the lamp through the pupil of the patient's right eye. If the examination be conducted properly, the pupil will appear of a bright-red color. The observer should then look for the optic disc, which is situated rather to the inner side of the axis of the eyeball; he will know that the disc is in view from the alteration in color of the pupil, which will turn from red to white or pinkish white. Having obtained the peculiar reflection of the optic disc, the observer (taking care to relax his own accommodation) should approach the eye until an interval of only 2 inches separates his cornea from that of the examined eye. Some difficulty will be experienced in keeping the eye illuminated, increasing as the distance between the observed and the observer becomes less; this, however, will be overcome by practice. When the observed eye has been approached to within a distance of 2 to 3 inches (supposing both the examining and examined eye to be emmetropic), a distinct erect and greatly magnified image of the parts occupying the fundus of the latter should be obtained; most observers will, however, find the image sharpened in outline and detail by using a weak *concave* lens behind the sight-hole of the ophthalmoscope. Should either the observer or the patient be myopic, it will be found necessary, in order to examine the erect image, to place behind the sight-hole of the ophthalmoscope a concave lens which rather more than neutralizes the existing ametropia.

The examination of the erect image, although requiring considerably more practice than that of the inverted, should never be neglected, as it gives much more satisfactory evidence of minute changes in the fundus oculi, all the parts being seen highly magnified (about fourteen and a half times). It gives, however, a less extensive field of vision, on account of the size of the objects, which only allows small portions of them to be seen through the pupil at one time.

The optic disc, retinal vessels, and other parts occupying the fundus should be examined by looking in different directions through the pupil, the observed eye being kept steadily fixed during the examination upon some distant and suitably situated object.

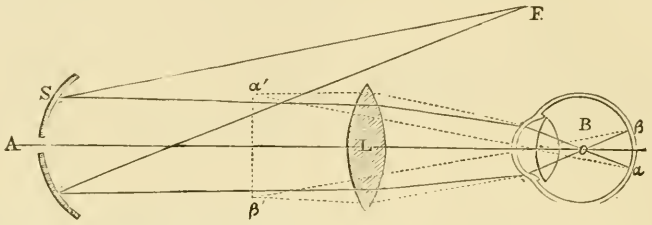
The right eye having been examined, the lamp should be placed on the patient's left side and the manœuvre repeated, the observer using the left hand and left eye instead of

[1] Sixteen and thirteen dioptrics, metrical system.
[2] About seven and three dioptries, convex.
[3] About five, three, and one decimal five, dioptrics concave.

the right hand and right eye. The condition of refraction of the eye can be diagnosed by the direct method of examination.

Indirect Ophthalmoscopic Examination.—In this method of examination an inverted aërial image of the fundus oculi is formed by the interposition of a bi-convex lens between the observer and observed eye. (See Fig. 107.)

FIG. 107.



A observer's, B observed, eye. F, the light. S, the mirror. L, the bi-convex lens. α β, some portion of the retina or the disc. α′ β′, its inverted aërial image formed between the mirror and bi-convex lens. (From Carter's translation of *Zander on the Ophthalmoscope.*)

The position of the patient and observer should be the same as for the direct examination; the same lamp also can be used, but should be placed rather farther back and kept on the patient's left side during the examination of either eye. The ophthalmoscope should be held in the same manner and the light reflected through the pupil as detailed above; but, the red reflection having been obtained, the observer must not approach the eye, but remain at a distance of about 18 inches.

The patient should be directed to look at some distant object so situated that the axis of the observed eye is turned slightly inward; this brings the optic disc (which lies somewhat to the inner side of the optic axis) opposite the ophthalmoscope, and its peculiar bright reflection will be at once observed.

The bi-convex lens should then be held in front of the observed eye at a distance about equal to its own focal length from the cornea, and steadied by the observer resting his ring-finger and little finger on the patient's brow. By this means an inverted image of the optic disc and vessels of the retina is immediately seen, which, although apparently within the eye, is in reality formed in the air between the observer and the bi-convex lens, and (in emmetropia) at a distance from the latter corresponding to its focal length.

If the image of the disc appear indistinct, the observer may be sure that his own eye is not accommodated for the distance at which the image is situated, which is, in reality, shorter by some inches than it appears to be. Should this be the case, the observer must increase the tension of his accommodation or withdraw somewhat farther from the observed eye.

A better method, however, than either of the foregoing is to employ habitually behind the sight-hole of the ophthalmoscope a convex ocular lens of about 10 or 12 inches[1] focal length. If this be done, a clear and well-defined image will always be obtained without tension of accommodation, provided precautions be taken that the distance between the observer's eye and the image be *not greater than the focal length of the convex ocular lens.*

The disc and parts immediately surrounding having been examined, the patient should be directed to look straight forward, so as to bring the region of the yellow spot opposite the ophthalmoscope; this having been carefully examined, the eye should be turned upward, downward, to the right and left, so that all parts of the fundus may be examined in turn.

In the indirect method of examination the observer should use his right eye and hold the ophthalmoscope in his right hand and the bi-convex lens in his left in examination of the right eye, and *vice versâ* in examination of the left.

DIFFICULTIES OF OPTHALMOSCOPIC EXAMINATION.

Considerable practice is required in order to become proficient in the use of the ophthalmoscope; the beginner will be frequently much disheartened at his want of success. Some of the difficulties are only to be overcome by practice; others are easily remedied. Reflections of the mirror from the two surfaces of the object lens often prove very troublesome; the inconvenience arising from this source is obviated by holding the lens

[1] Four or three dioptrics.

somewhat obliquely, when the two images will recede from each other and leave a clear space between them. Reflection from the surface of the cornea may be troublesome, but can usually be overcome by a little manœuvring. Contraction of the pupil is also an insurmountable obstacle to the beginner, but can be removed by dilatation with atropine; for this purpose a solution of one grain to one ounce of water should be dropped into the eye about half an hour before the examination is made, or the patient may be ordered to use a solution of one-eighth grain to one ounce two or three times on the day preceding it. When experience has been gained, however, atropine can be dispensed with, except in some few cases or in those where it is necessary to make a very careful examination by lateral illumination.

If the patient be directed to look at a distant object, the accommodation is relaxed, and sufficient increase in the pupillary area will generally take place.

Every ophthalmoscopic examination should be conducted on a certain definite system.

The first step should be to examine the condition of the refractive media by lateral illumination.

Next, the condition of refraction of the eye and the state of the vitreous chamber should be ascertained by the direct method of examination.

Thirdly, a general survey of the fundus oculi should be made by the indirect method.

And, fourthly, any abnormalities having been discovered by the indirect examination should be fully and carefully studied in detail by the direct method.

If this systematic plan of examination be carried out, few mistakes will be made, and no abnormality of importance is likely to be overlooked.

Normal Appearance of Parts seen by the Ophthalmoscope.

The refractive media (cornea, aqueous humor, lens, and vitreous), as stated under "Lateral Illumination," are perfectly transparent.

The retina is either quite transparent and colorless, or in dark eyes may appear as a faintly gray cloud covering the choroid; its position is marked by that of its blood vessels. The bright-red reflection previously mentioned is due to the blood in the choroid; the depth in color of the reflection varies with the amount of pigmentation of this vascular tunic: in blue or gray eyes it is light red, in dark ones of a much deeper tint, and in the negro appears to be dark blue. The parts of the fundus oculi requiring special attention are the optic disc and parts immediately surrounding it and the region of the yellow spot.

The disc appears at first sight to be of a uniform pale pink color, but on closer examination different portions are found to present different shades.

Its centre is pale, or even white; next to this succeeds a zone of pink, this being again bounded by an apparently double border of lighter color. The pale appearance of the central portion of the disc is caused by connective tissue surrounding the blood vessels in this situation. The succeeding pink zone consists entirely of nerve fibres and delicate capillaries. The outer pale double border is formed by the margins of the sclerotic and choroidal rings, which do not accurately cover each other, the choroidal ring being somewhat greater in diameter than the sclerotic opening, the margin of which, being left uncovered by pigment, shines through the transparent nerve fibres.

Both the white central portion and the outer ring are in some cases so distinctly marked that the appearance produced might be taken by an inexperienced observer as evidence of disease, but both conditions are perfectly consistent with health. From the pale central portion of the disc proceed the retinal blood vessels; these appear upon its surface usually at the same point, but may emerge separately or in groups of two or three.

As a rule, about eight vessels are seen upon or close to the disc, four of these being arteries, with a corresponding number of veins; two of each pass upward and a like number downward, to be distributed over the retina. The lateral branches are comparatively insignificant, and are given off from the principal trunks either upon the nerve surface or in the retina near its margin.

Distinction between Arteries and Veins.—The veins are distinguished from the arteries by being of greater calibre, the proportion being about 3 to 2. There is also a difference in color between the two, the veins being the darker; the arteries are marked by a double contour and their central portion is much lighter than their borders.

Occasionally a dark spot is noticed in one of the vessels at its origin or termination in the disc. This might be taken for a clot, but the appearance is caused by a peculiar

arrangement of the vessel, which at this point is seen, as it were, on end and foreshortened.

Spontaneous pulsation of some of the retinal *veins* may also be observed; the occurrence of *venous* pulsation is, however, perfectly consistent with health and has no pathological import.

In any eye, pulsation, both arterial and venous, can be produced by pressure upon the globe, but should it occur spontaneously in the *arteries* has the gravest significance. (See "Glaucoma.")

Anomalies of Optic Disc, etc., consistent with Health.

Certain phenomena are not unfrequently observed with the ophthalmoscope which, although contrary to the condition usually met with, are perfectly consistent with a normal state of the parts.

The appearances caused by the connective tissue surrounding the central vessels, the occurrence of pulsation, unusual distribution, and existence of dark spots in the latter, together with the unusual distinctness of the sclerotic ring, have been already mentioned.

Other anomalies are:

1. **A dark crescentic figure** bordering some portion of the margin of the disc. This appearance is caused by a peculiar arrangement of the choroidal pigment; it is congenital.

2. **Variations in the depth of color of the disc** are frequently met with. Due regard must be had to the color of the surrounding fundus in forming an opinion as to whether the tint in any particular case is so much deepened or lessened as to constitute a diseased condition.

In light eyes the disc appears much redder than in dark, the apparent difference being due more to contrast with the surrounding parts than to actual change in color.

Slight deviations are only to be determined by careful examination and long experience.

3. **Excavation of the Optic Disc.**—Not unfrequently a sloping, or even an abrupt, depression is met with occupying the centre of the disc, but usually extending somewhat farther toward the yellow spot than in other directions. The whole nerve surface, however, is never included in the cup; the vessels do not bend under its edge, their calibre is not altered, neither is spontaneous arterial pulsation observed, as may be the case in the excavation of glaucoma. (See "Glaucoma.")

4. **Persistence of the Hyaloid Artery.**—Occasionally a small whitish cord may be seen extending from the centre of the disc to the back of the lens; it is the remains of a vessel which during fœtal life nourished the latter structure.

5. **Senile Changes.**—As age advances the refractive media become less transparent, the retina grows somewhat hazy, and the disc appears whiter than natural.

6. **An appearance of white wisp-like patches,** extending from some part of the margin of the disc over the surrounding fundus. These patches have irregular jagged borders and are often of considerable size; the retinal vessels pass through and are obscured by them. Occasionally white threads may be continued for a considerable distance along the sides of the vessels.

The patches are caused by the opaque nerve sheaths, which should end at the lamina cribrosa, being accidentally continued beyond this point into the transparent retina; they are congenital and do not interfere with vision.

7. The **choroidal vessels** are at times (especially in light eyes) very plainly visible, appearing as an irregular network of pale pink bands.

The region of the yellow spot presents in health no very marked ophthalmoscopic signs, but requires special notice, as it is frequently the seat of pathological lesions. In the normal condition it is recognized by the absence of blood vessels, which appear to avoid this part of the retina and pass above and below it, by some deepening in color, and occasionally an indistinct, dark, transversely oval figure can be detected.

IV. Examination by Manipulation.

The fourth method of examination, *by manipulation*, consists simply in ascertaining the tension of the globe by digital pressure. The examination should be conducted as follows:

Tension of Globe.—The patient being directed to look downward and close the

eye gently, but not to screw up the lids, the surgeon should make gentle alternate pressure with the forefinger of each hand placed upon the closed upper lid; the pressure should be made in a direction backward and somewhat downward, so as to compress the globe against the floor of the orbit.

In health the eyeball is firm, tense, and semi-fluctuating; in disease the tension may deviate in the direction of increase or decrease. The degree of tension may be expressed as follows:

If normal, as Tn; if above par, as T + 1, T + 2, T + 3, according to the amount of increase; if below par, as T − 1, T − 2, T − 3. If a doubt exist, as T + ? or T − ?, according as the doubt is on the side of increase or decrease.

REFRACTION, ACCOMMODATION, ACUTENESS, AND FIELD OF VISION.

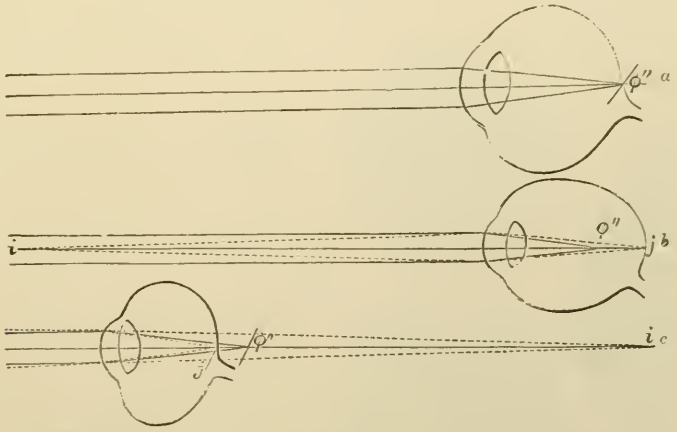
Definition.—By refraction of the eye we understand the power which the refractive media (cornea, humors, and lens) possess by virtue of their curvatures and densities of bringing together *parallel* rays of light and forming them into an image at a certain spot (known as the principal focus of the refractive or dioptric system) *without the employment of any adjusting power.*

The refraction is said to be *normal* or *abnormal* according to the position of the retina with regard to the focus of the dioptric system. The former condition is known as *emmetropia*, the latter as *ametropia*, the terms "normal" and "abnormal" being seldom applied.

Emmetropia.—The emmetropic eye (Fig. 108) is of such a shape that the retina is situated at the focus of the *dioptric system*, and in such a position that a distinct and inverted image of any object (*the rays of light proceeding from which are parallel*) is formed upon the layer of rods and cones.

Ametropia.—The ametropic eye differs from the emmetropic in two opposite directions; the deviations are known as *anomalies of refraction.* In the first and (in this country[1]) most commonly met with anomaly the retina lies *within* the focus of the dioptric system—that is to say, the axis of the eyeball is too short from before backward;

Fig. 108.[2]



a. Emmetropia. *b.* Myopia. *c.* Hypermetropia.
(From Donders, *Accommodation and Refraction of the Eye.*)

and images of objects the rays of light proceeding from which are parallel are formed behind the retina instead of in its substance. This anomaly is known as *hypermetropia*, or far sight. (See Fig. 108, *c.*)

To the second anomaly an opposite state of things pertains: the axis of the eyeball

[1] It is generally believed amongst English, and is also supported by continental, ophthalmologists that in this country hypermetropia is of more frequent occurrence than myopia. It appears to me that the reverse may obtain. We are rarely in hospital practice consulted about slight myopia, as it gives no inconvenience. On the other hand, a very slight degree of hypermetropia may incapacitate the seamstress, skilled mechanic, or clerk; so that, whereas we get all degrees of hypermetropia, we are only applied to in the higher degrees of myopia.

[2] In these diagrams φ″ shows posterior focal points of the dioptric system; *j*, in *b* and *c*, the abnormal position of the retina.

from before backward is too long; consequently, the retina lies outside the focus of the dioptric system, and the image of an object the rays of light coming from which are parallel is formed in front of it. This anomaly is known as *myopia*, or short sight. (See Fig. 108, *b*.)

Diagnosis of Anomalies of Refraction.—*The diagnosis* of anomalies of refraction can be made by trial with lenses, by *direct* ophthalmoscopic examination, and by "keratoscopy." If we wish to diagnose and measure the degree of anomalies of refraction by trial with lenses, we must be provided with a set of trial glasses and a book of Snellen's test types. (See p. 265.)

The trial glasses which have now come very generally into use are arranged according to what is known as the "metrical system." The unit in this system is a lens of one metre focal length; it is called a "dioptric" (= D). A lens of two dioptrics is double the strength of that of one dioptric and has a focal length of half a metre (50 centimètres), and so on. The box of trial glasses contains convex and concave spherical and cylindrical lenses. It can be obtained from any good optician.

Test of Refraction by Lenses.—We test refraction with lenses as follows: Having placed our patient at 6 metres from the sheet on which are printed letters from D = 6[1] to D = 60, we direct him to look toward it. Should he be hypermetropic, he will be able to make out all or most of the letters; he will already have told us that he cannot see to do near work or read for any length of time without the eyes becoming fatigued and vision growing misty. We ascertain how many of the letters can be read by each eye separately. Should both eyes read the same letters, we hold before them convex glasses, beginning with +1 D, and continue the trial until we have ascertained *the strongest convex* lens with which the greatest attainable acuteness of vision is still maintained. Thus, supposing our patient reads D = 6 at 6 metres, we find the strongest convex lens with which he can still read D = 6; should he read D = 12 without a convex lens and D = 6 by the aid of one, we find the strongest with which he can still read D = 6; if we cannot improve vision so that he reads more than D = 12, we find the strongest convex glass with which he can still read D = 12, and so on. Should there be a difference between the two eyes, we must test the refraction of each separately, keeping one covered during the trial of the other. The strongest convex lens which still allows the patient to see as well at a distance as is possible, either with or without the aid of glasses, shows a part of the accommodative power which he was obliged to exercise in order to bring parallel rays of light to a focus upon the retina of his too-short eye. The employment of such a lens prevents this waste of accommodation and reserves it to be used when required for near work.

Should our patient be myopic, he will probably tell us that he is near-sighted; he will make out but few or none of the letters at 6 metres; if the small types be given him to read, he will hold them near the eyes, but will make out the smallest provided the book be held close enough.

We notice at what distance the small types can be read by each eye separately, and, as in hypermetropia, if there be no difference between the two, test their refraction together.

We tell our patient to look toward the sheet on which are the letters from D = 6 to D = 60, and hold before his eyes concave lenses beginning with that the negative focal length of which corresponds to the distance at which small types are read.

Thus, if the small types can be read at 20 centimètres, we begin the trial with a lens of 5 D, the negative focal length of which is 20 centimètres.

We continue the trial until we have found the *weakest concave* lens with which distant letters can be most plainly seen. Should our patient by the aid of any concave lens be able to read D = 6 at 6 metres, we find the *weakest* with which D = 6 can still be read. Should he be able only to make out D = 24, D = 12, etc., we must still find the weakest concave lens with which the best vision is attainable.

As in hypermetropia, should there be a difference between the two eyes, we test each eye separately.

We must be careful to ascertain *the weakest* lens with which the best vision for distant letters is attainable, because we wish only to so open out the pencil of parallel rays of light as to allow of their being brought to a focus in the retina of the too-long eyeball.

If we give too strong a lens, our patient will see equally well; but then we have opened out the pencil of parallel rays too much, and he must use his accommodative power in order to overcome the excessive divergence.

[1] The smaller letters D = 5, D = 4, D = 3, etc., placed at their proper distances, will do equally well if we have not a distance of 6 metres at disposal.

Diagnosis by the Ophthalmoscope.—In the diagnosis and measurement of anomalies of refraction by direct ophthalmoscopic examination we act upon the same principle as in the diagnosis by trial with lenses—with this exception, however, that we use our own eye as a test, instead of the patient's vision.

As stated at p. 257, nothing of the details of the fundus of the emmetropic eye can be *clearly* made out until we have approached it very near. Now, on the contrary, should any object occupying the fundus be *clearly seen* whilst we are still separated from the observed eye by a considerable interval, we may be certain that we have to deal with an anomaly of refraction.

The question now arises, Is the case one of hypermetropia or myopia? We answer the question by ascertaining whether the object we see is viewed in an erect or inverted position. If the former, the eye is hypermetropic; if the latter, it is myopic. We can ascertain the position of the image by moving our head from side to side. If the image be erect it will move in the same, if inverted in an opposite, direction to the movements of the head.

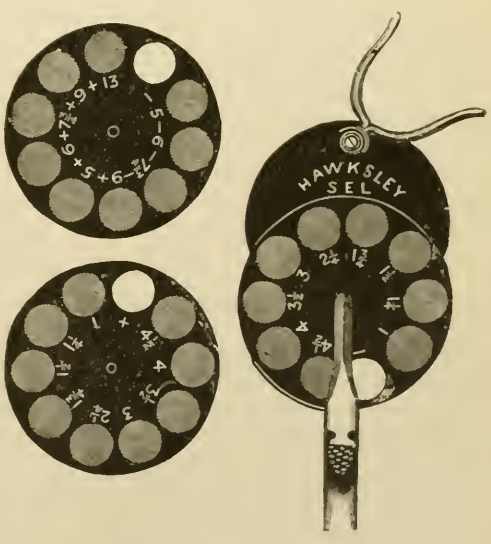
If we wish to ascertain the amount of hypermetropia or myopia present, we take one of the ophthalmoscopes mentioned below, go as close as possible to the patient's eye, revolve the lens containing discs placed at the back of the instrument until we have ascertained, in hypermetropia the strongest convex, in myopia the weakest concave, lens with which we can still see clearly the optic disc and retinal vessels.

The number of dioptries of the strongest convex or weakest concave lens with which the greatest attainable acuteness of vision *for distant letters* is still maintained expresses what is known as the degree of "ametropia." Thus, we say that an eye which sees as clearly or more clearly through a convex lens of two dioptries has a hypermetropia of 2 D, an eye of which the acuteness of vision is most improved by a concave lens of three dioptries has a myopia of 3 D, and so on.

The same holds good in the measurement of anomalies of refraction by the ophthalmoscope. The strongest convex lens in a case of hypermetropia, the weakest concave in one of myopia, through which a clear view of the fundus can still be obtained, expresses the degree of "ametropia" present.

Two very useful ophthalmoscopes by means of which anomalies of refraction can not only be diagnosed, but also accurately measured, have been devised—one (Fig. 109) by Mr. Charles J. Oldham of Brighton (see *Report of Fourth Ophthalmic Congress*, 1872), and another by Mr. W. L. Purves; the latter is, I think, the more convenient of the two.[1]

Fig. 109.



Oldham's Ophthalmoscope.

The third method of ascertaining the form, and also the degree, of ametropia by "keratoscopy," is conducted as follows: The patient, being seated, and the lamp placed rather behind the level of the face, is directed to look straight forward. The observer should stand or sit at a distance of about a metre and a quarter, and with the ophthalmoscope reflect the light from the lamp upon the patient's eye. As soon as the bright red reflection of the fundus is seen the mirror should be rotated. If ametropia be present, a shadow will be seen to pass across the illuminated area. The diagnosis of the anomaly present is decided by the direction of this shadow. If it passes in the same direction as the rotation of the mirror, the eye is myopic; if in the opposite direction, the eye is hypermetropic.

In slight degrees of ametropia and emmetropia the shadow is so faint as to be made out with difficulty; if seen at all, it moves in the same direction as the mirror in slight M, slight H, and E.

[1] Many other refraction ophthalmoscopes are in use, but the two mentioned, and another smaller and cheaper instrument known as Loring's ophthalmoscope, will be found as useful as any.

We can ascertain the degree of anomaly present by finding, in myopia, the weakest concave lens which, held before the eye, makes the shadow begin to move against the mirror; in hypermetropia, the strongest convex lens which causes the shadow to begin to move with the mirror.

In the examination of refraction by keratoscopy it is well to have the pupil and accommodation fully under the influence of atropine or other mydriatic.

The observer must be naturally emmetropic or made so artificially.

The TREATMENT of anomalies of refraction consists mainly in neutralizing the defect by suitable spherical lenses. We must, however, in myopia take care not to give too strong glasses.

For further information on the subject of refraction the reader is referred to works treating specially of ophthalmic subjects, more especially to that on *The Accommodation and Refraction of the Eye* (Donders).

Accommodation.

By accommodation is meant the power which the eye possesses of altering the condition of its refractive media so as to form upon the retina images of near objects the rays of light from which are divergent equally as distinct as images of more distant ones the rays of light from which are parallel or nearly so.

The power of accommodation depends upon the elasticity of the crystalline lens, the curvature of which can be increased to a considerable extent; the alteration of curvature is brought about by the action of a ring of inorganic muscular fibres situated between the sclerotic and choroid, just external to the greater circumference of the iris. This ring is known as the *ciliary muscle*. The manner in which the ciliary muscle acts upon the lens is as yet a disputed point, one theory being that the lens is maintained in a flattened condition by tension of its suspensory ligament so long as the eye is adjusted for a distant object—that upon accommodation for a near one the ligament is relaxed by contraction of the muscle and the curvature of the lens (more especially that of its anterior surface) increased by virtue of its own elasticity. The other theory is that the ciliary muscle compresses the lens in some manner and so alters its curvature.

Range of Accommodation.

We speak of the range of accommodation, and by it we mean the power of a lens, which we suppose the crystalline adds to itself when we change our look from the farthest to the nearest point of distinct vision. Thus, an eye which sees clearly at infinite distance when its accommodation is relaxed, and at 16 centimètres with greatest tension of accommodation, has a range or "amplitude" of accommodation equal to a lens of $\frac{100}{16} = 6$ D. about.

Accommodation is accompanied by convergence of the optic axes from the action of the internal recti muscles and by contraction of the pupil.

Diseases of Accommodation.

Paralysis of accommodation is met with in cases of paralysis of the third nerve accompanied by ptosis, divergent strabismus, and more or less dilatation of the pupil; it may be caused by injuries, as blows on the eyeball itself or in its vicinity; sometimes it is met with without apparent cause, not unfrequently in persons recovering from diphtheria or from any exhausting disease, and accompanied by no paralysis of the external ocular muscles; it can always be produced artificially by the use of atropine or other mydriatics.

SYMPTOMS.—Dilatation of the pupil, general mistiness of vision, and inability to see near objects plainly, the last condition being capable of correction by the use of a convex lens.

TREATMENT.—This depends on the cause; if the paralysis of accommodation be associated with paralysis of other branches of the third nerve, the treatment must be directed against any existing constitutional condition—syphilis, rheumatism, etc.—most improvement being brought about by the use of iodide of potassium in increasing doses, alone or in conjunction with bichloride of mercury. If dependent on injury, the eye should be kept bound up and inflammatory symptoms treated as they arise. If arising idiopathically, without apparent cause, a solution of sulphate of eserine should be used

two or three times a day in order to stimulate the ciliary muscle to contract, and attention paid to the general health. In any case, a convex lens may be used if required.

Spasm of accommodation is met with in some cases of hypermetropia, and occasionally in myopia; it often masks a considerable amount of hypermetropia, and may at times even make the eye appear to be myopic. If it exists with myopia, the degree of short sight is increased.

SYMPTOMS.—Severe and constant pain in the eyeballs and forehead, increased on any attempt to use the eyes, and associated with some anomaly of refraction (generally hypermetropia), inability to see near or distant objects distinctly, these symptoms being modified or entirely removed by the use of atropine.

TREATMENT.—Paralyze the accommodation by the constant use of a strong solution of atropine (gr. iv of sulphate of atropia to ℥j of water) and accurately neutralize any existing anomaly of refraction by suitable lenses.

ACUTENESS OF VISION.

By acuteness of vision we understand the perceptive and conductive power of the structures concerned in sight: this may be ascertained by the use of test types—*i. e.*, letters of certain definite proportions which can be recognized by a fairly sharp-sighted eye at certain distances, which distances are marked over each set of letters.

The book of test types we use is that of Dr. Snellen; in it we find types variously numbered from .5 to 60, the former being .5 of a metre, or 50 centimetres, the latter 60 metres, at which distances the types can be read by an emmetropic eye of normally acute vision. The book of types can be obtained of Williams & Norgate, Henrietta street, Covent Garden [or of any optician in the large cities of the United States].

FIELD OF VISION.

By the field of vision we understand the area over which objects situated in the same vertical plane can be distinguished, the eye being kept fixed on some point. The limits of the field of vision are marked by the most excentrically placed points of objects which can still be distinguished, the direction of the visual axis of the eye being unaltered.

Mode of Ascertaining the Extent of the Visual Field.—The extent of the visual field is easily measured by either of the two following methods:

1. The patient, being placed at a distance of 12 inches from a blackboard about 3 feet square having a white cross in the centre, should be directed to look steadily at the cross, which must be situated on a level with the eyes; one eye being closed, the sensibility of the retina of the other should be tested by moving a piece of chalk fixed on a dark handle from all directions toward the cross, a mark being made at the point where the chalk first becomes visible.

The whole area limited excentrically by a line joining the points at which the chalk is first seen when approaching from every direction is known as the *quantitative field* of vision, in contradistinction to an area bounded excentrically by much narrower limits, over which objects are distinctly defined and letters can be read, etc., known as *the qualitative field of vision.*

2. Another very simple and effectual method of investigating the condition of the visual field is conducted as follows:

Having placed the patient in a convenient position, we stand opposite to him, at a distance of about 2 feet, and, supposing his left eye to be examined, we direct him to look steadily at our right eye, which is opposite to his left; the patient's right eye and our left being kept closed, we then move our hand in various directions in the peripheral parts of the field and notice if its movements are perceived by the patient at the same distance from the centre as by our own healthy retina.

Care must be taken that the hand is moved in a vertical plane situated midway between our own and the patient's eye, and not nearer one than the other; we must also take care that he keeps his eye fixed.

Supposing that the eye under examination distinguishes all movements of the hand at the same distance from the centre as our own, we decide that his field of vision is normal; but if a falling off is noticed in any particular direction, we infer that the sensibility of the corresponding portion of retina is impaired.

It must be remembered that each part of the visual field corresponds to a part of the retina opposite to, and not on the same side as, the object seen; *e. g.*, suppose that the

movements of the hand are not perceived in the outer half of the field, the inner half of the retina is defective, and *vice versâ*.

It must also be borne in mind that the height of the bridge of the nose has a considerable influence in limiting the inner half of the visual field. Limitation or contraction of the visual field is a very constant accompaniment of retinal changes; it is also one of the earliest symptoms of glaucoma, and occurs as a physiological condition with advancing age.

Stereoscopic Test for the Retina.—A very simple and effectual method of testing the sensibility of the retina has been devised by Mr. Joseph Towne of Guy's Hospital: it consists in presenting simultaneously to non-corresponding halves of the two retinæ similar objects.

The examination is carried out by means of a stereoscope provided with two slides; on each slide are two white semicircles described upon a red ground, those on the one slide being so contrived that when looked at through the stereoscope they correspond to the nasal halves of the two retinæ, whilst those on the other slide correspond to the two malar halves. In cases of want of sensibility of the whole or any part of the retina, from whatever cause arising, a part or the whole of one or both semicircles corresponding to the affected portion of retina appears misty or entirely obscured. The degree and extent of the mistiness or obscurity is governed by the degree of insensibility and extent of the impaired portion of retina. Mr. Towne has made the stereoscopic test for the retina the subject of some very interesting papers in *Guy's Hospital Reports*, series iii., vols. xi., xii., xiv., xv.

DISEASES AND INJURIES OF THE EYEBALL AND ITS APPENDAGES.

Several of the more important affections of the organ of vision will be briefly alluded to in future pages; the present section is devoted to a short description of those diseases and injuries which (with a few exceptions; *e.g.*, glaucoma) do not call for operative interference.

THE EYELIDS.

Congenital Anomalies.—Absence of the eyelids, a failure of closure of the fœtal fissure leaving a cleft in one or both lids (coloboma), ptosis, complete or partial, development of a third lid, pigment spots, moles, nævi, and warty growths have all been occasionally met with.

Ulcers.—Simple ulcers, primary venereal sores (chancres), syphilitic and cancerous ulceration, are sometimes met with. The first three require to be treated on general medical principles; the last by operation, if the disease has not proceeded too far.

Phthiriasis.—The pediculus pubis (crab louse) is sometimes found amongst the eyelashes close to the margin of the lids. The edges of the lids appear to be covered with scabs and crusts somewhat resembling tinea; on close examination the insects themselves will be discovered adhering closely to the margin of the lids, their eggs being attached to the lashes near their bases.

Treatment.—The daily use of some kind of mercurial preparation, none being better than the Ung. Hydrarg. Ammoniatum.

Paralysis of the orbicularis muscle occurs in some cases of facial paralysis: there is inability to close the eye, the lower lid falls away from the globe, there is considerable collection of lachrymal secretion at the inner canthus, and constant watering of the eye consequent on the displacement of the lower tear punctum.

Treatment.—General medical treatment should be adopted.

Spasm of the orbicularis muscle may occur from long-continued intolerance of light consequent on affections of the cornea.

Treatment must be directed against the corneal affection. (See "Diseases of the Cornea.")

Spontaneous twitching, more especially of the lower lid, popularly known as "live blood," is met with in some cases of hypermetropia or in persons whose digestions are out of order; it is very probably a symptom of undue contraction of the ciliary muscle.

Treatment.—Correction of existing hypermetropia, instillation of atropine, and attention to the general health.

Inflammation of the eyelids may occur during or after acute diseases (measles,

scarlatina, etc.), in the course of erysipelas, as the result of injuries, or in connection with severe inflammation of neighboring parts; *e.g.*, purulent ophthalmia. The swelling and redness are usually considerable and the eye cannot be opened; the inflammation generally ends in resolution, but may (especially if it result from measles, scarlatina, etc.) go on to the formation of abscess, or even to sloughing of the skin.

TREATMENT.—Locally, fomentations with hot water or decoction of poppy-heads; if an abscess form, it should be opened—preferably through the conjunctiva.

The patient's general health should also be attended to.

Stye ("**hordeolum**") is a small red and painful swelling situated on the outer surface of the lid or near its margin, and consists in a circumscribed inflammation of the lid dependent on morbid change in the Meibomian glands. Styes generally occur in weakly, delicate persons; several may appear simultaneously, or there may be a succession of them; they give rise to considerable irritation and are often extremely painful. The inflammation usually goes on to suppuration.

TREATMENT.—Fomentations, poultices, the administration of tonics, and good living. When pus has formed, the little tumors should be opened.

Tinea (ophthalmia tarsi).—Patients suffering from tinea present themselves with yellowish-brown dry crusts hanging to the eyelashes, which have often dropped out to a considerable extent.

In old cases the margins of the lids are much thickened, giving rise to displacement of the lower tear punctum and consequent watering of the eye. On removing the crusts the margin of lid will be found ulcerated, fissured, and easily bleeding. The disease consists in inflammation and ulceration about the roots of the lashes; it runs a very chronic course, often lasting for years in spite of remedies.

TREATMENT.—Slight cases can generally be cured by the use of a lotion containing four to six grains of alum to the ounce of a water, applied three or four times a day, and of mild nitrate of mercury ointment (one part of the ordinary nitrate of mercury ointment to eleven of lard[1]) smeared along the margins of the lids night and morning.

The patient should be directed to remove all the crusts before applying the ointment.

More severe cases should be treated by pulling out the lashes and removing the scabs with forceps, and then applying solid nitrate of silver to the raw surface left.

In cases where the lower tear punctum has become everted the punctum and canaliculus must be slit up. (See p. 296.)

Injuries.—Wounds of the eyelids, however extensive or ragged, should, after having been thoroughly cleansed, be brought accurately together; they will usually heal readily enough. Should there be any loss of substance, an endeavor must be made to prevent distortion of the lids by contraction of the resulting cicatrix.

Ecchymosis of the lids (black eye) frequently occurs as the result of blows, and may be caused by leech-bites or operations.

TREATMENT.—Most cases may be left alone; but if it is desirable to get quickly rid of the effused blood, a poultice made of equal parts of the scraped root of black bryony and bread crumbs should be applied. The poultice should be kept on as long as the patient can bear it. The application is often accompanied by a good deal of stinging pain.

Emphysema of the lids sometimes occurs from rupture of the mucous membrane of the nose, air being forced into the cellular tissue of the eyelids on sneezing or blowing the nose. Gentle pressure with cotton-wool and a bandage and avoidance of violent expiratory movements, sneezing, etc., is the only treatment required.

The Lachrymal Apparatus.—The principal affections of the tear passages, etc., will be described in the next section.

THE CONJUNCTIVA.

Ophthalmia.—Under this head are collected all the different forms of inflammation of the conjunctiva. The following characters are common to all: more or less vascularity of the membrane, uneasiness and stiffness of the lids, pain of a smarting character, some kind of discharge, and gumming together of the lids during sleep.

Inflammation of the conjunctiva has to be distinguished from inflammation of the sclerotic or subconjunctival fascia or the injection of these structures which is present in many of the inflammations of deeper parts of the globe. The distinction can be made by paying attention to the following points:

[1] The ointments employed in the ophthalmic department at Guy's Hospital are now almost invariably prepared with vaseline instead of lard.

Diagnosis.—1. The inflamed conjunctiva is bright red, the vessels are large and tortuous and anastomose freely, forming a dense network; they are of greater calibre about the fornix and taper off toward the cornea.

The inflamed sclerotic or episcleral tissue is pinkish or bluish in color; the vessels are small and straight, and the vascularity is usually most marked in a ring around the eyeball just external to the corneal margin.

2. The vessels of the conjunctiva can be somewhat displaced and made to glide over the surface of the eyeball by gentle pressure; those situated in deeper parts cannot be made to alter their positions.

3. The pain in inflammation of the conjunctiva is of a smarting character, while in inflammations of deeper parts it is dull and aching and often very severe.

Treatment.—Inflammations of the conjunctiva are best treated by astringent applications.

Any of the following formulæ may be employed:

Strong Alum Lotion.

Alum, gr. x; Water, ℥j.

Useful in cases of purulent ophthalmia.

Alum Lotion.

Alum, grs. iv to vj; Water, ℥j.

Sulphate of Copper Drops.

Sulphate of copper, gr. ij; Water, ℥j.

Sulphate of Zinc Drops.

Sulphate of zinc, gr. ij; Water, ℥j.

Nitrate of Silver Drops.

Nitrate of silver, gr. j; Water, ℥j.

Chloride of Zinc Drops.

Chloride of zinc, gr. ij; Water, ℥j.

Most useful in cases of chronic ophthalmia.

Atropine and Astringent Solution.

Sulphate of atropia, gr. ½ to gr. ij; Sulphate or chloride of zinc, gr. ij; Water, ℥j.

Useful in cases where iritis or corneitis occurs in the course of ophthalmia.

Antiseptic Lotion.

Boracic acid, gr. xv; Water, ℥j.

Useful in purulent ophthalmia and sloughy ulceration of the cornea.

Any of these remedies may be given to the patient to use himself; they should be applied from three to six times a day or oftener, and the patient should be directed to wash away all discharge before using any of them, and to take care that the lotion goes well between the lids.

Some kind of ointment (spermaceti, mild nitrate of mercury, etc.) should also be ordered to be smeared on the margins of the lids at night, to prevent their becoming gummed together during sleep.

The condition of the patient's general health should also be attended to.

Other applications, which should be used by the surgeon himself, are—

The mitigated nitrate of silver stick (consisting of nitrate of potash and nitrate of silver in the proportion of three parts of the former to one of the latter.—*Green stone—lapis divinus* (consisting of equal parts of alum, nitrate of potash, and sulphate of copper, with a small quantity of camphor)—and *solid nitrate of silver.* In order to apply any of these the patient should be seated in a chair and the surgeon, standing behind, as in Fig. 110, should evert the lids and lightly rub their conjunctival surface with either. If a preparation of nitrate of silver be employed, the conjunctiva should be washed with salt and water immediately after the application.

Varieties of Ophthalmia.

Catarrhal ophthalmia is commonly caused by draughts of cold air, is highly contagious, and acute in its course.

The conjunctiva, both ocular and palpebral, is highly injected and sometimes swollen; there may be small extravasations of blood in the structure of the former; there is a thick yellow, tenacious discharge.

One or both eyes may be affected, the disease usually commencing in one, and spreading to the other in the course of two or three days.

Treatment in the early stages, before there is any amount of discharge. Some soothing application (as decoction of poppy-heads) should be employed; later on an astringent should be used, and some mild nitrate of mercury or spermaceti ointment smeared on the edges of the lids at bedtime, to prevent their becoming gummed together during sleep.

The patient (or, in the case of a child, its parents) should be warned of the contagious nature of the disease, and no sponges, towels, etc., which he is in the habit of using should be used by other people. Among the poorer classes it is very common to see a whole family suffering from catarrhal ophthalmia.

Chronic ophthalmia is usually a sequel of some more acute form; the palpebral conjunctiva is reddened, the ocular conjunctiva presenting patches of slightly increased vascularity, but no general redness, as in cases of catarrhal ophthalmia; the lids are often somewhat thickened and the caruncle and semilunar fold swollen. There is slight mucous discharge, which forms dry crusts on the margins of the lids, and at the inner canthus overflow of tears may occur from obstruction or displacement of the tear puncta.

Treatment, the same as that of catarrhal ophthalmia. The disease may continue for almost any time; and when one remedy appears to have lost its effect, another should be tried.

Phlyctenular ophthalmia, usually met with in children and young adults, especially females, is characterized by the existence of small whitish elevations on the conjunctiva, most commonly near the margin of the cornea; each little elevation has a wisp of blood vessels leading to it if near the corneal margin, and is surrounded by a zone of vascularity if situated in any other part of the conjunctiva. There is some watering of the eye and slight mucous discharge.

Patients are frequently met with who suffer from repeated attacks of phlyctenular ophthalmia.

Treatment.—In treating phlyctenular ophthalmia our object is to set up a certain amount of irritation of the conjunctiva, by which the phlyctenulæ will be destroyed. This can be attained by dusting calomel into the eye daily, or by ordering a small quantity of an ointment containing two grains of yellow oxide of mercury to ʒj of lard or vaseline, to be applied to the inner surface of the lower lid at bedtime. Either of these remedies will soon cause the phlyctenulæ to disappear. The disease, as affecting the conjunctiva covering the cornea, will be spoken of under diseases of that structure. Tonics should be given if required.

Granular Ophthalmia.—This disease occurs at all ages and is very common amongst the lower classes, especially the Irish; it is highly contagious. Granular ophthalmia is often very prevalent where large numbers of persons are crowded together in workhouses, parish schools, barracks, etc. It would appear that in those who have lived for a considerable time under unfavorable hygienic conditions a peculiar granular state of the palpebral conjunctiva becomes developed. Persons thus affected are said to be predisposed to granular ophthalmia. The predisposed eyelid is characterized by the existence of small pale spherical bodies situated in the structure of the conjunctiva; the little bodies much resemble and are known as sago grains; they are most constantly found upon the lower lid, near the outer canthus.

This predisposed or granular condition of the eyelids may remain stationary for an unlimited time without giving rise to inconvenience; but, on the other hand, attacks of inflammation are ever liable to be set up, giving rise to the development of granular ophthalmia as we see it in practice.

We meet with three principal forms of granular ophthalmia, which may be distinguished from each other by the nature of the granulations present:

One, characterized by the predominance of the sago grains, already alluded to, around which inflammation has been set up, is known as "follicular granulation."

Another form, characterized by the predominance of hypertrophied papillæ, by which the sago grains, if they exist, are obscured, is known as "papillary granulation."

A third form, characterized by a mixture of follicular granulations and hypertrophied papillæ, is known as "mixed granulation;" this is the most severe form of the three.

In old cases, and especially those that have been treated by strong caustics, the conjunctiva may be found converted into a mass of rough harsh cicatrices and its secreting power destroyed, the condition known as "xerophthalmia" being developed.

Granulations in active granular ophthalmia, unlike the sago grains which characterize the predisposed lid, are always found most developed on the conjunctiva covering the attached border of the tarsal cartilage of the upper lid. Their appearance is more or less altered by treatment; they are accompanied by thick yellow discharge, and there may be more or less severe intolerance of light.

Sequelæ of Granular Ophthalmia.—The cornea may become more or less opaque and vascular, especially at its upper part; the condition is known as "pannus," and is caused by constant irritation of the cornea by the rough surface of the lid.

The conjunctiva may be destroyed to a greater or less degree, extensive cicatrices being formed, which by their contraction cause shrinking of the membrane and distortion of the lids, giving rise to entropion and narrowing of the palpebral aperture. The hair bulbs may become displaced, causing the eyelashes to be misdirected—"trichiasis." (See p. 292.) The results of granular ophthalmia are frequently aggravated by unskilful treatment.

Treatment.—In treating granular ophthalmia our object is to destroy the granulations with as little damage as possible to the conjunctiva itself.

The use of strong caustics must be carefully avoided, as they cause too much destruction of tissue, followed by the formation and subsequent contraction of cicatrices.

Slight cases can be cured in a short time by the application of mitigated nitrate of silver stick twice a week or oftener, and the use of sulphate of copper drops from three to six times a day.

More severe cases will remain under treatment for months or years, but if persevered with will improve greatly, and may ultimately recover. If the ophthalmia be of recent date, the granulations should be touched twice a week with the mitigated nitrate of silver stick, or if possible every day, sulphate-of-copper drops being used from three to six times daily.

In chronic cases the green stone should be used instead of the nitrate of silver stick.

The application of calomel powder or quinine to the granulations has also been found useful in some cases.

When the cornea is completely opaque and fleshy-looking, inoculation with pus from a case of purulent ophthalmia may be tried, but only in extreme cases; otherwise, we may do more harm than good by causing sloughing of the cornea. Should but one eye be affected, care must be taken to prevent the other becoming inoculated.

Iritis not unfrequently supervenes in the course of granular ophthalmia; when it occurs, a solution of atropine should be dropped into the eye from three to six times daily, in addition to other remedies.

Pannus requires no special treatment, and if not very dense disappears as the granulations are cured. In all cases some simple ointment should be applied to the edges of the lids at night, to prevent their becoming gummed together.

Purulent Ophthalmia.—Purulent ophthalmia may be met with as "ophthalmia neonatorum" in children soon after birth, or in older persons. In the former case it may be caused by contact of acrid vaginal secretions, by want of cleanliness and fresh air, or a combination of the two; in the latter by contact with some form of specific pus or by constant irritation of the already inflamed conjunctiva. It is highly contagious.

The worst form of the disease, whether occurring in infants or older persons, is that caused by inoculation with gonorrhœal matter—"gonorrhœal ophthalmia."

"Ophthalmia neonatorum" makes its appearance a few days after birth: the eyelids are found red or bluish-red and swollen; the eyes can only be opened with difficulty, and on attempting to separate the lids thick yellow purulent discharge escapes from between their edges; both eyes are almost always affected.

Purulent ophthalmia in older persons may affect one or both eyes; it commences with intolerance of light, lachrymation, and injection of the conjunctiva, at first much resembling an ordinary attack of catarrhal ophthalmia, but in about twelve to twenty-four hours its real nature becomes apparent by thick yellow discharge from between the swollen, red, and sometimes everted lids. The conjunctiva is bright scarlet, traversed by large distended blood vessels, and much swollen, especially the ocular portion (chemosis), which may overlap the cornea and protrude in folds between the lids; there is pain and intolerance of light, and there may be much depression, especially if the attack have lasted long. The patient may be suffering from gonorrhœa. The great danger to be feared in purulent ophthalmia is implication of the cornea, which may be partially or entirely destroyed by suppuration or sloughing.

Treatment.—In all cases the patients themselves or their parents should be warned

of the contagious nature of the disease; and if one eye only be affected, the greatest care should be taken to protect the other. If possible, a good view of the cornea should be obtained, as its condition materially influences the prognosis with regard to sight. The examination should be made with care, as the cornea may be ruptured whilst making it.

In ophthalmia neonatorum the only treatment required is to wash out the eyes every hour or half hour with strong alum lotion (see p. 268) until the discharge is lessened; the lotion need only be used thus frequently for twelve hours out of twenty-four (from 8 A. M. to 8 P. M.), the child being allowed to sleep at night; as the discharge gets less the lotion may be used less frequently. Some simple ointment should be applied to the margin of the lids once or twice a day to keep them from sticking together.

Slight cases of purulent ophthalmia in older persons may be treated in the same manner, but the more severe forms (especially the gonorrhœal) require that much more energetic measures be taken.

The treatment should be both local and constitutional.

Local Treatment.—When the patient is first seen, the lids should be everted and the whole conjunctiva brushed over with a stick of solid nitrate of silver or painted with a solution of forty to sixty grains of the salt to ℥j of water; the application should be repeated in the course of two or three days if no improvement have taken place. The patient should be kept lying down in a dark room and a bag of ice or lint kept wetted with iced water applied over the closed lids; the ice or lint should be removed and the eyes washed out every hour or half hour with some astringent or antiseptic lotion, the greatest cleanliness being observed.

Should there be much pain and the patient be strong, blood may be taken from the temples by leeches or the application of the artificial leech; but, as before stated, most patients suffering from severe purulent ophthalmia are much depressed and will not bear depletion.

Constitutional Treatment.—The free administration of tonics, especially iron and quinine, with good living and a fair amount of stimulants.

If perforation of the cornea threaten or have taken place, the eye should be kept firmly bandaged, so as to prevent as much as possible any escape of the contents of the globe.

Diphtheritic Ophthalmia.—This form of ophthalmia is but rarely met with in London [or America]; it affects persons of all ages. At first sight the case appears to be one of severe purulent ophthalmia; its chief characteristic, however, is a solid infiltration of the substance of the conjunctiva, with or without the formation of diphtheritic membranes on its surface. The affected eye is frequently lost from implication of the cornea. The disease is best treated by sedative applications, as fomentations of poppy-heads, or belladonna, attention being paid to the patient's general health.

Injuries.—Wounds of the conjunctiva usually heal readily enough, requiring only simple treatment.

Burns are usually caused by contact of lime or hot metals; the damage done may be only slight, or the whole conjunctiva and cornea may be converted into a dead white slough.

TREATMENT.—The conjunctiva should be carefully examined and all foreign bodies and portions of sloughy tissue removed; should the injury have been caused by lime, the surface of the conjunctiva must be carefully cleansed with a weak solution of acetic acid or simple warm water. Some oil should be placed between the lids and the eye bound up with wet lint and a bandage. If any symptoms of iritis appear, a solution of atropine should be dropped into the eye from three to six times a day. Should there be much discharge, alum lotion may be used.

When the sloughs have separated, care must be taken to prevent adhesions between the raw surfaces left by passing a probe between the lids and eyeball once or twice a day and directing the patient to draw the lid away from the globe frequently.

Foreign bodies—small pieces of coal, iron, etc.—are sometimes found embedded in the conjunctiva, and must be removed.

Hemorrhage into the substance of the conjunctiva or beneath it may occur spontaneously or from injury; no treatment is necessary. The patient may be assured that no harm will come of it, and that the blood will disappear in the course of a week or longer.

EXTERNAL MUSCLES OF THE EYEBALL.

Strabismus will be considered in the next section.

Nystagmus signifies a peculiar involuntary quivering motion of both eyes, dependent on rapid contraction of antagonistic pairs of muscles. The disease is usually

developed in infancy, and is always associated with considerable impairment of vision, arising from congenital cataract, opacity of the cornea after purulent ophthalmia, atrophy of choroid, etc. Nystagmus occurs in some nervous disorders, as locomotor ataxy; also in persons who work in bad light, as those employed in mines, when it is described as "miners' nystagmus."

TREATMENT.—Nothing can be done to remedy nystagmus in the two first classes of cases, but miners' nystagmus may be entirely cured by removing the patient from his work and the administration of tonics.

Paralysis and Paresis.—Paralysis signifies total loss of power of the affected muscle; paresis, only partial loss.

The symptoms of paralysis and paresis are double vision and total loss or impairment of mobility of the eye in some particular direction.

The causes are affections of the brain or spinal cord; diseases within the orbit, as tumors, nodes, or inflammatory exudations, pressing on the nerves supplying the muscles; and affections of the nerves themselves or of the muscles. As a rule, the cause of the paralysis or paresis can only be conjectured, but very many cases will be found connected with syphilis.

TREATMENT.—A careful inquiry should be made into the patient's previous history, and remedies given in accordance with this, those of an anti-syphilitic nature being generally required. If the affection has not lasted more than three months, a favorable prognosis may be given; but if, on the contrary, it has existed six months or more, recovery is very improbable.

Paralysis of all the external muscles of the eye, "ophthalmoplegia externa" (Hutchinson), is occasionally met with. The eye looks nearly straight forward and is almost immovable; there is partial ptosis.

The disease is probably of syphilitic origin, but is little influenced by treatment; it is often associated with symptoms of serious central disease.

Insufficiency of the internal recti muscles gives rise to somewhat obscure symptoms, which have been mistaken for manifestations of cerebral disease.

Patients thus affected complain that they cannot do near work for any length of time, as objects looked at become indistinct or appear double. They suffer from giddiness and pain in the brows and head generally. Insufficiency of the internal recti should always be suspected if in a case of hypermetropia relief cannot be given by the use of glasses.

TREATMENT.—Any anomaly of refraction should be accurately neutralized and the weakened muscles assisted by the use of prisms, or of spherical lenses so arranged as to have a prismatic action.

THE CORNEA.

Inflammation (corneitis, or keratitis).—Five different forms of inflammation of the cornea are met with: (1) Simple corneitis; (2) interstitial or parenchymatous corneitis; (3) pustular corneitis; (4) keratitis punctata; (5) corneitis with sloughing or suppuration.

SYMPTOMS.—Corneitis is characterized by watering of the eye, impairment of vision, intolerance of light, and pain, at times severe, at others insignificant; on examination more or less of the cornea will be found cloudy or quite opaque, and blood vessels may be seen in its substance or on its surface.

DIAGNOSIS.—It is of importance to notice the course and position of the blood vessels in any case where the cornea has become vascular. Should the vessels lie altogether in the cornea, commencing near its margin and passing for a variable distance in its substance, the case is probably one of interstitial keratitis; but should the vessels be continuous with those of the conjunctiva, pass over the margin of the cornea, and lie superficially on its surface, the vascularity is probably due to mechanical irritation from granular lids or inverted lashes, and the condition known as *pannus* is present.

It is very necessary that the difference between these two forms of vascularity should be recognized, as their treatment varies widely.

In the former case the treatment of keratitis, to be presently described, should be adopted; in the latter, treatment must be directed against the cause of the vascularity (granular lids, etc.).

Simple corneitis may be caused by injuries or the lodgment of foreign bodies on the surface or in the substance of the cornea. There is some pain, intolerance of light, and lachrymation, and some part of the cornea is found occupied by a halo of dulness.

Interstitial or parenchymatous keratitis (corneo-iritis, syphilitic keratitis, keratitis, diffuse keratitis, vascular corneitis).—Interstitial keratitis occurs as a rule in

persons who are affected by hereditary syphilis: it is frequently, but by no means invariably, associated with changes in the teeth, pegged canines, notched incisors, or dome shape of first molars; flattened nose, fissures around the angles of the mouth, or other manifestations of congenital syphilitic disease.

It usually first makes its appearance between the fifth and eighteenth years, but has been seen as late as thirty; it always affects both eyes, either simultaneously or at short intervals; it runs a very chronic course and is most intractable, a severe attack often lasting from twelve to eighteen months.

Symptoms.—Interstitial keratitis presents all the symptoms of inflammation of the cornea in a marked degree. The opacity is peculiar, and is caused by infiltration of the substance of the cornea with opaque material.

At first the cornea becomes spotted in its centre, but the spots soon run together, forming a grayish haze; opacity then commences at the upper and lower corneal margins and gradually spreads, until the whole structure resembles somewhat a piece of ground glass, apparently blood-stained in parts, from the development of innumerable minute blood vessels. There is always a well-marked band of ciliary injection. Interstitial keratitis is not unfrequently complicated by iritis; hence the name "corneo-iritis."

The opacity, having reached a certain point, may remain stationary for months, but at length clearing commences and the cornea regains more or less of its normal transparency, recovery always taking place to a much greater extent than would be at first expected. In some few cases a choroido-iritis is set up, and the eye eventually shrinks.

Pustular corneitis (phlyctenular, strumous, vascular, corneitis; strumous ophthalmia, fascicular keratitis).—Pustular corneitis is met with in children and young adults: it often follows measles, scarlatina, or other acute diseases; it is frequently accompanied by eczematous eruptions on the eyelids, about the nostrils and angles of the mouth, and on the head; the patients often present well-marked strumous diathesis and are generally said to be delicate.

Symptoms.—In most cases there is profuse lachrymation, accompanied by great intolerance of light; the lids may be swollen, covered with eczematous eruption, and tightly screwed up, so as to cause the greatest difficulty in examination.

There is more or less injection of the ciliary region (ciliary redness). Upon the surface of the cornea may be found (1) small grayish elevations (phlyctenulæ); (2) phlyctenulæ in a state of suppuration (pustules); (3) small ulcers left on discharge of the contents of the latter. Any of these are usually found in greatest quantity round the margin of the cornea, but its whole surface may be found dotted over with phlyctenulæ, pustules, or ulcers, or examples of all three may be met with in the same eye. There is more or less haziness and vascularity surrounding the affected portions of cornea. In some cases there is thick mucous or muco-purulent discharge in addition to the lachrymation.

Cases of pustular corneitis accompanied by great intolerance of light, much swelling of the eyelids, profuse lachrymation, and thick muco-purulent discharge, occurring in strumous children, are sometimes described as a separate disease under the name of "strumous ophthalmia."

Fascicular keratitis is a somewhat rare form of the disease, characterized by the existence of a fasciculus of vessels running on to the cornea from its margin, the fasciculus terminating in a small ulcer, phlyctenula, pustule, or small inflamed patch of cornea.

Pustular corneitis is very likely to recur.

Keratitis punctata occurs, as a rule, in young adults, rarely in children, but may be met with at all ages as a part of sympathetic ophthalmia; it much resembles the early stages of interstitial keratitis and probably arises from the same cause. As a rule, one eye only is affected; there are the usual symptoms of corneitis, but the intolerance of light is not very severe; the cornea is dotted over with small grayish opacities, which are collected most thickly in its central portion and on careful examination will be found to occupy the posterior layers of the structure. The disease is most intractable and may be accompanied by iritis.

Corneitis with sloughing or suppuration is usually the result of sharp blows, as flicks from twigs, etc., or is caused by the irritation of foreign bodies, as the husks of corn; it may also occur after operations for cataract.

Symptoms.—Those of corneitis, severe pain being, as a rule, one of the most marked; some part of the cornea will be found occupied by a collection of pus, part of which may have escaped into the anterior chamber and collected at its lower part, giving rise to the

condition known as "hypopyon," or the pus may have gravitated down between the layers of the cornea to its lower margin, forming a collection much resembling hypopyon and known as "onyx." Suppurative corneitis is met with in cases of *neuro-paralytic ophthalmia*, a peculiar form of inflammation associated with paralysis of the ophthalmic division of the fifth nerve and consequent anæsthesia of the parts supplied by it.

Instead of a collection of pus, some part of the cornea may be found occupied by a dead white slough or a large ulcerated and sloughing surface.

The iris may also be inflamed and suppurating.

TREATMENT.—The treatment of corneitis should be both local and constitutional.

Local Treatment.—All foreign bodies or other sources of irritation should be removed; the eyes must be protected from light by a large shade, protectors, or, better still, by a bandage. Sedative applications should be employed, none being better than belladonna lotion containing from six to ten grains of extract of belladonna to one ounce of water, or, if preferred, a weak solution of atropine, gr. ½ to a pint of water, may be used instead; the eyes should be bathed three or four times a day with either of these and kept bound up with lint wetted with one or the other.

If iritis exist, a stronger solution of atropine, gr. ½ to gr. ij or iv to the ounce of water, should be dropped into the eyes as often as may appear necessary.

In corneitis with suppuration warm applications will be found most beneficial; the eye should be well bathed with warm belladonna lotion or decoction of poppies several times a day and bound up firmly with lint soaked in one or the other. If pain be a prominent symptom, it may be greatly relieved by taking blood from the temples. Should a large area of the cornea become infiltrated with pus, a free incision should be made by transfixing with a cataract knife and cutting out obliquely through the centre of the infiltrated portion.

In cases of corneitis, especially of the pustular form, where there is obstinate intolerance of light and the disease constantly relapses or recurs in spite of other treatment, a seton should be placed in the skin of the temple on one or both sides. (See p. 291.) In some cases the spasmodic contraction of the orbicularis may be kept up by the irritation of small fissures at the outer canthus; in such, a free division of the junction of the lids and orbicularis by cutting through the canthus will often effect a speedy cure.

The inhalation of chloroform is also said to act beneficially in some cases.

If in a case of suppuration or sloughing perforation of the cornea appear imminent, iridectomy should be performed. (See p. 304.)

Constitutional Treatment.—Simple corneitis requires no constitutional treatment. In the interstitial form anti-syphilitic remedies should be employed. To older patients the bichloride of mercury in doses of one-sixteenth to one-twelfth of a grain, combined with bark or other tonic, should be given twice or three times a day; to young children, hyd. cum cret. gr. j to v three times a day.

The other forms of corneitis, especially the pustular, are best treated by the administration of tonics, as steel wine, dialyzed iron, tincture of perchloride of iron, quinine, etc.; and in strumous children cod-liver oil should also be prescribed, with good living and plenty of fresh air.

Ulcers of the cornea present a great variety of forms. They may be transparent or opaque; they may be healing, indolent, vascular, or sloughing. The depth to which the corneal tissue is destroyed varies from slight abrasion of its surface to destruction of its whole thickness, causing perforation. The area of the cornea which is destroyed also varies from a small point to its whole surface.

Ulcers are sometimes described as marginal or central, according to their position. Ulceration of the cornea is constantly met with in cases of debility, from whatever cause arising. It is very common in patients recovering from acute diseases, as measles, scarlatina, and more especially smallpox, from impaired nutrition, not from formation of pustules or eruption on the cornea. Children are much more frequently affected than adults.

The SYMPTOMS of ulceration are very similar to those of corneitis. On examination, any kind of ulceration may be found (one variety has been mentioned under "Pustular Corneitis"). There may be one or more small *transparent ulcers*, which can only be seen in certain lights and are very likely to be overlooked. They appear like small abrasions of the epithelium; sometimes the greater part of the surface of the cornea is found to be affected either by several small transparent ulcers or one large one. This form of ulceration is most commonly met with in adults of irritable, nervous temperament, and should always be carefully looked for when a patient of this description presents himself suffer-

ing from severe intolerance of light, watering of the eye, and smarting pain without any very apparent cause.

Opaque ulcers are visible enough; they may be of any size or number. At times they appear to be healing; in which case, the edges appear smooth and the surface of the ulcer rough and opaque or cloudy. At others they are indolent, and again they may be spreading, when their edges are found to be clean cut, as if a piece of the cornea had been punched out by some sharp instrument; the surface of the ulcer appears glassy and is often deeply excavated.

Sloughing ulcer is more or less opaque, spreads rapidly, both in area and depth, and if the process be not soon arrested the cornea will be perforated and a prolapse of the iris of greater or less extent (according to the size of the perforation) will take place. If the opening be large, the lens or some of the vitreous may escape.

In the greater number of cases of perforation of the cornea the iris pushes forward, fills the opening, and becomes adherent to its margins, forming an "anterior synechia;" but a considerable prolapse may take place, forming a projection or bulge from the surface of the cornea—"staphyloma."

Marginal or crescentic ulcer (ulcus corniæ serpens) is a somewhat peculiar form of corneal ulceration; it is met with in persons of middle age, is very intractable and very liable to recur or relapse. This form of ulceration is accompanied by very severe pain, great intolerance of light, and very profuse lachrymation. On examination, a crescentic patch of ulceration is found, skirting, generally, the upper margin of the cornea; the ulcer is deep, its margin clean cut, and its surface glassy-looking.

The ulceration spreads rapidly up to a certain point, remains stationary for a time, and then commences to heal slowly, the healing process being frequently interrupted by relapses.

The ulcerative process may involve both the upper and lower segments of the cornea, but never pass up to its centre.

TREATMENT.—The treatment of ulcers of the cornea is very similar to that of corneitis. In many cases, however, more especially those of marginal ulcer, the instillation of solutions of sulphate of eserine (gr. j to iv to ℥j of water) three times a day or oftener will be found most beneficial. In all severe cases the eye should be kept carefully bandaged. Iridectomy should be performed in any case should perforation be imminent. (See p. 304.)

Opacities of the cornea are the result of inflammation, ulceration, or injury.

They are met with of all densities and sizes; thin cloudy opacities are known as "nebulæ," dense white ones as "leucomata." A dense white opacity involving the whole cornea is called a "total leucoma;" an opacity of the same description occupying a part only, a "partial leucoma." Should a corneal opacity have been caused by a perforating ulcer or wound of the cornea, an "anterior synechia" will probably be found associated with it.

False Pterigium.—*Fleshy opacities* are sometimes met with near the margin of the cornea and continuous with the conjunctiva. They are composed of granulation tissue, and are frequently the result of burns.

TREATMENT—Corneal opacities have always a tendency to disappear, especially in children. Their removal may be aided by the use of slightly irritating applications which set up a certain amount of increased vascularity and thus aid absorption. The remedies generally employed are drops of sulphate of copper, iodide of potassium, or opium; turpentine, pure, or mixed in various proportions with olive oil; calomel powder, or the yellow oxide of mercury ointment. Any of these may be used for some considerable time. Should no improvement have taken place at the end of two or three months and the opacity be so situated as to interfere with vision, an artificial pupil must be made; and if the opacity be disfiguring, it should be tinted. (See p. 302.) The fleshy opacities may be removed by operation, but are very liable to reappear in their former site.

Injuries.—Abrasions of the cornea may be caused by scratches from thorns, ends of straw, finger-nails, etc. They give rise to severe pain, much intolerance of light, and watering of the eye.

TREATMENT.—The eye should be kept carefully bandaged with lint soaked in belladonna lotion till the abrasion has healed.

Penetrating wounds of the cornea generally involve the iris or lens; in the former case an adhesion of the iris to the cornea (anterior synechia) is likely to be formed, or iritis set up; in the latter the lens will probably become opaque, a traumatic cataract being developed.

Very extensive wounds of the cornea may allow the escape of the lens or vitreous.

TREATMENT.—The eye should be kept carefully bound up with lint soaked in belladonna lotion; and in cases where the lens has been wounded or iritis set up a solution of atropine one grain to one ounce of water should be dropped into the eye from four to six or eight times daily.

Should the lens swell and cause pain and increase of tension, it must be removed without delay or iridectomy must be performed.

Iridectomy may have to be performed at some future time for optical reasons or to obviate the irritation caused by dragging on an anterior synechia. Traumatic cataract may also require to be treated.

Burns of the cornea by lime, hot metals, etc., usually occur in conjunction with like injuries of the conjunctiva; they usually leave behind them opacities of greater or less extent and density, according to the severity of the injury, or may cause sloughing and destruction of the whole or greater part of the cornea.

TREATMENT, the same as that of burns of the conjunctiva.

THE SCLEROTIC AND EPISCLERAL TISSUE.

Episcleritis.—Inflammation of the sclerotic or episcleral tissue, or more commonly of both together, is a somewhat rare disease; it is characterized by the presence of purple swollen patches covered by enlarged conjunctival vessels and situated usually about the insertion of the recti muscles.

The purple patches often disappear from one portion of the globe and appear again at another; the inflammation is chronic in its course, but subsides after a time, leaving some discoloration of the affected part; it is very liable to recur.

It occasionally follows operations for strabismus.

TREATMENT.—Sedative applications, as decoction of poppy-heads or belladonna fomentation, should be used three or four times a day; and if there be much conjunctival vascularity or any mucous discharge, some astringent lotion, as chloride-of-zinc drops (see Formulæ, p. 268), should also be employed.

Any constitutional treatment that may appear called for should be adopted. In some cases tonics do most good; others, again, may be greatly benefited by a course of mercury or iodide of potassium.

This disease is usually described as "episcleritis."

Staphyloma.—A bulge of the sclerotic may occur from softening of its structure by inflammatory changes, which usually commence in the choroid.

Staphyloma may be met with in the ciliary region (ciliary staphyloma), about the equator (equatorial staphyloma), or near the optic nerve (posterior staphyloma). Little can be done in the way of treatment.

Gummata are occasionally seen upon the sclerotic; they occur as vascular, well-defined bosses, either singly or in groups of two or three. Their diagnosis is not easy; they are likely to be confounded with sarcoma or patches of episcleritis. From the former they can be distinguished by their course, which is, though slowly, toward recovery; from the latter, by being more abruptly defined and raised above the surface of the globe.

They are generally associated with syphilitic history, and often with other manifestations of syphilis. They require vigorous anti-syphilitic treatment.

Injuries.—The sclerotic may be wounded by sharp instruments or ruptured by blows; in the latter case the lesion usually takes place in the ciliary region, near the upper margin of the cornea.

The sclerotic (as also the cornea) may be pierced by a shot or chip of metal, which may be lodged within the globe or have passed clean through it.

TREATMENT.—The treatment of injuries of the sclerotic depends much upon the extent and nature of the damage done.

Small incised wounds will usually heal readily enough if the eye be kept carefully bandaged. Larger wounds may require to be closed by a suture.

Blows often cause complete disorganization of the globe, the aqueous and vitreous chambers being filled with blood and hemorrhage having taken place between the sclerotic and choroid, although no rupture of the external tunic has occurred.

Such cases must be carefully watched and the eye kept bandaged with lint soaked in belladonna lotion.

In cases of extensive incised wounds, large ruptures, or wounds associated with lodg-

ment of a foreign body within the globe, extirpation of the eyeball will probably have to be performed. (See p. 313).

THE CRYSTALLINE LENS.

Congenital Anomalies.—Variations in shape, absence of the whole (aphakia) or part of the lens, and displacements are met with as congenital defects.

Presbyopia (old sight).—Presbyopia depends on senile change of the crystalline lens, by which it is rendered harder than in youth and its elasticity is impaired. As a consequence, its curvature can only be altered to a limited extent by the action of the ciliary muscle, and the power or range of accommodation is correspondingly diminished.

Persons generally begin to experience the effects of presbyopia about the age of forty-five. The nearest point of distinct vision, which year by year has been receding from the eyes, now becomes inconveniently far off, so that small print can only be read with difficulty or not at all; distant vision, however, still remains acute.

It has been arbitrarily decided that a person shall be considered presbyopic as soon as his nearest point of distinct vision comes to stand at 22 centimètres or farther from the eyes, and the degree of presbyopia is expressed by the number of dioptries (D) which it is necessary to give the eye in order to bring its near point up to this distance, or, in other words, to give it an accommodative power equal to 4.5 D, which is the power of the lens which the crystalline must add to itself in order to see distinctly at 22 centimètres. Thus, a person aged forty-five can only see distinctly at 28 centimètres—that is, he can only add to his crystalline a lens equal to 3.5 D. In order to enable him to see distinctly at 22 centimetres, we must give a lens which makes up the difference between 3.5 D and 4.5 D—*i. e.*, 1 D. A person of forty-five, therefore, requires a convex lens of 1 D to remedy his presbyopia; the number of this lens also expresses the degree of presbyopia.

It has been determined by observation that presbyopia increases by one dioptric for every period of five years from forty to sixty, sometimes by one dioptric and sometimes by a half only for each similar period from sixty to eighty.

The following table shows the lens required at each period of five years by the emmetropic eye. Should hypermetropia exist, its degree must be ascertained and added to the number given in the table. The degree of myopia, on the contrary, must be subtracted:

Age.	Dioptries.	Age.	Dioptries.	Age.	Dioptries.
40	0	55	3	70	5.5
45	1	60	4	75	6
50	2	65	4.5	80	7

Should our patient require to see at some particular distance, the numbers in the table need not be adhered to: he may be allowed to select those lenses which he thinks suit best. As a matter of fact, we often find that the glasses given in the table are too strong, especially in hypermetropic persons who have become presbyopic before taking to glasses. Such persons have long been accustomed to strain their accommodation to the utmost, and will not thank us for giving them glasses which neutralize the whole of their hypermetropia as well as their presbyopia. We shall give much greater satisfaction by ordering glasses which a little more than neutralize the hypermetropia, and so give a little help without being an absolute correction.

Injuries.—Opacity of the lens (traumatic cataract) may be caused either by penetrating wounds of the cornea or simply by concussion.

Dislocation of the Lens.—As the result of blows upon the eyeball, the lens may become partially or entirely displaced; it may still retain its transparency, but often becomes more or less opaque.

Displacement of the lens may take place upward or downward, laterally, forward into the anterior chamber, backward into the vitreous, or it may be entirely extruded from the globe through a wound in the sclerotic and lie beneath the conjunctiva. In the first three positions the displacement is only partial, and the margin of the lens can be seen by oblique illumination occupying some part of the pupil.

In displacement forward the pupil will be found dilated, irregular in shape, and fixed; oblique illumination will show the lens lying partially or entirely in the anterior chamber.

In displacement backward the iris will be tremulous, the pupil sluggish, and the anterior chamber deepened. Direct ophthalmoscopic examination will probably detect the lens lying in the ciliary region at the lower part of the eye.

In displacement beneath the conjunctiva the lens is found forming a small rounded tumor somewhere near the corneal margin, most frequently at its upper part.

Treatment.—If the lens be displaced partially or into the anterior chamber and still retain its transparency, it may be left alone. But should it become opaque or appear to be setting up irritation, it should be removed by extraction, preferably associated with iridectomy. A transparent lens may remain for years in the anterior chamber and, with the exception of impairment of vision, give rise to no inconvenience. If its capsule has been lacerated, however, it will become opaque, and if not extracted will gradually be removed by absorption.

A lens displaced into the vitreous chamber will very probably act as a foreign body and set up glaucomatous changes, in which case it should be removed at all risks; but if it produces no irritation, it is best left alone.

A lens displaced beneath the conjunctiva may also be left to itself.

Cataract will be considered in the section on operations.

THE IRIS AND CHOROID.

Congenital Anomalies.—Coloboma signifies a cleft condition of the iris or choroid dependent on failure of closure of the fœtal fissure. In the iris it occurs as a deficiency of the lower segment, appearing as if iridectomy had been performed downward. In the choroid it is seen (on examination with the ophthalmoscope) as a brilliant white figure, commencing at the optic disc and continuing downward and forward for a variable distance toward the ciliary processes, through which, in extreme cases, the cleft may extend, and be even continuous with a similar deficiency of the iris.

In the **Albino** the pigment of the iris and choroid is absent to a greater or less extent, and with the ophthalmoscope the fundus of the eye appears of a yellowish-white color.

Irideremia, or congenital absence of the iris, is occasionally observed.

Persistency of the Pupillary Membrane.—Small portions of the membrane which at a period of fœtal life covered the pupil occasionally remain, and may be seen as one or more fine threads, somewhat resembling cobwebs, passing across the pupillary area and attached at either end to the anterior surface of the iris, near the margin of the pupil.

Anomalies of Color.—The iris of one eye may be brown, that of its fellow being blue, or difference in color may occur in different parts of the same iris.

Tremulous iris (iridodonesis) signifies a tremulous condition of the iris, which shakes about as the eye is moved. This condition is met with when the iris has lost the support of the crystalline lens, when the vitreous humor is abnormally fluid or the iris totally paralyzed.

The term *paralysis* should, strictly speaking, be applied only to cases where the iris is tremulous, all its proper movements being destroyed and the pupil of moderate size; but it is often used in the condition of dilatation of the pupil met with in some cases of paralysis of the third nerve, in which, however, only the circular fibres are affected.

Mydriasis signifies abnormal dilatation of the pupil; **Myosis,** abnormal contraction.

Cases are occasionally met with in which the ciliary muscle, circular and radial fibres of the iris are all paralyzed, the pupil is of medium size and does not act. The disease has been called "ophthalmoplegia interna" by Mr. Hutchinson.

Tumors seldom originate in the iris itself, but its structure often becomes implicated by growths commencing in deeper parts of the globe (see "Tumors of Eyeball"); instances, however, of malignant growths, dermoid and simple cysts, and of the cysticercus have been met with in the iris.

Inflammation of the Iris (Iritis).

Causes. *Local.*—Irritation from foreign bodies in the conjunctival sac or cornea; friction of the cornea by granular lids or inverted lashes; injuries to the iris itself by operations or accidents, with or without the lodgment of foreign bodies in its substance or on its surface; pressure by a swollen crystalline lens and exposure from perforation of the cornea.

Constitutional.—Debility after acute disease, overlactation, etc.; certain specific diseases, as syphilis, rheumatism, and gout.

Symptoms.—The following symptoms are met with in most cases of iritis: changes

of color, cloudiness and loss of polish of the iris, sluggishness or complete immobility and (as a rule) contraction of the pupil, injection of the ciliary region (ciliary redness), watering of the eye, and impairment of vision. Other symptoms met with occasionally are pain, intolerance of light, irregularity in outline of the pupil, inflammatory products—pus or lymph nodules—visible to the naked eye.

Three **varieties** of iritis are commonly met with: 1. Simple iritis; 2. Recurrent or rheumatic iritis; 3. Syphilitic iritis.

Simple Iritis.—All the more constant symptoms of iritis are present, often accompanied by more or less severe pain. An uncomplicated attack lasts from one to two weeks or longer, and usually ends in resolution, the iris quite recovering its normal condition, but a few adhesions may form between the iris and lens capsule (posterior synechiæ). In this as well as in the other forms of iritis, however, the inflammation may run on to the formation of a considerable quantity of new material or into suppuration.

Recurrent or rheumatic iritis occurs in persons who are subject to attacks of rheumatism or gout, and also in the children of rheumatic or gouty parents. An attack of this form of inflammation presents all the more constant symptoms of iritis, and has one character peculiar to itself—viz., its tendency to recur, some patients having had as many as twenty or more separate attacks; in some cases the attacks observe a remarkable periodicity, recurring regularly at the same time of year. The inflammation sometimes appears in one eye, sometimes in the other, or perhaps in both—rarely, however, simultaneously, but at short intervals, the second eye becoming affected long before the first has begun to recover. Recurrent iritis is frequently accompanied by more or less haziness of the cornea and aqueous humor. In some cases very severe pain of a dull aching character is experienced in the eyeball, forehead, side of nose, and temple; in others, the attack is most insidious, the patient's attention not being attracted until a considerable amount of new material has been thrown out, extensive adhesions formed, the sight of one eye much impaired, and the inflammatory action extended to the other. The great feature of this form of iritis is its tendency to recur. The cause of the recurrences is not very evident; they are probably due primarily to "posterior synechiæ," and are prevented by the performance of iridectomy.

All persons, however, who have "posterior synechiæ" are not subject to recurrent iritis; so that in all probability in those who are liable to repeated attacks there is a tendency to the lighting up of inflammation upon very slight provocation, such as dragging of posterior synechiæ.

Syphilitic iritis is, perhaps, the most common of all the forms.

A typical case presents all the constant symptoms of iritis in a very marked degree, the zone of ciliary redness being extremely well defined. There may be, besides, certain peculiar nodular excrescences, of a dirty yellow color (known as lymph nodules), situated on the surface of the iris or at its pupillary margin and at times extending into the pupil, which may be completely blocked by them. These excrescences are syphilitic gummata, and their existence renders the diagnosis of syphilitic iritis certain; they are, however, only occasionally present, and in the greater number of cases met with the surgeon will have to take into consideration the patient's previous history, ascertain the existence of other signs of syphilis, and make his diagnosis accordingly.

Syphilitic iritis occurs most frequently between the ages of fifteen and forty, but is occasionally met with as a manifestation of congenital syphilis in infants, and often in cases of interstitial keratitis.

Results of Iritis.—In many cases, especially if early and properly treated, perfect recovery takes place; in others, permanent signs of inflammation are left. The morbid changes more commonly met with are—

1. The iris itself may be found *atrophied*, *rigid*, or *rotten*, and very prone to bleed freely on the slightest wound. These conditions become most apparent when operating upon its structure. On attempting to perform iridectomy considerable difficulty will be experienced in removing a portion of the iris, which may be so tough that none of it can be torn away or so rotten that only the portion included between the branches of the forceps is removed, or hemorrhage may take place to such an extent as to prevent the completion of the operation.

2. *Adhesions to neighboring parts* ("*synechiæ*") may have formed, those most commonly met with being between the iris and lens capsule ("posterior synechiæ").

Posterior synechiæ are generally situated at the pupillary margin, and vary in extent from a few adherent tags of this part only to complete adhesion of the whole posterior surface of the iris to the lens capsule, this latter condition being known as "total posterior synechia."

Adhesion of the iris to the cornea—"anterior synechia" (should this occur at all as the result of iritis)—will be found about its greater circumference.

3. *Closure of the pupil* by inflammatory material; *opacities upon the lens-capsule* caused by adhesion of the "uvea" detached from the posterior surface of the iris.

4. Dense inflammatory deposits in or beneath the capsule, or involving the superficial fibres of the lens itself (*capsular cataract*), may also be met with.

TREATMENT.—In treating iritis we must take care, *first*, to remove any local cause, such as a foreign body, opaque swollen lens, etc., and to cure granular lids or remove inverted lashes; *secondly*, we must endeavor to dilate the pupil; *thirdly*, to relieve pain; *fourthly*, any constitutional treatment that may appear called for should be employed. (The means of carrying out the first indication are detailed elsewhere.)

Local.—In order to dilate the pupil a few drops of a strong solution (gr. iv to ℥j) of sulphate of atropine should be placed between the eyelids by the surgeon himself at each visit, and a weaker solution (gr. ¼ to gr. 1 to ℥j) should be used by the patient from four to eight or twelve times a day. If the case is treated at the commencement, more or less dilatation of the pupil will usually take place; but should the iris have become infiltrated with inflammatory matter and adhesions formed, little or no effect will be produced. The atropine should, however, be persevered with.

Some patients are extremely intolerant of atropine; in such it produces swelling and inflammation of the eyelids and face of an erysipelatous nature, known as "atropism."

If atropism occur, a substitute must be found for the atropine. Daturine, hyoscyamine, duboisine, hematropin, or other mydriatics, may be tried, or the atropine may be used in the form of an ointment, gr. ¼ of sulphate of atropine to ℥j of vaseline. In one case I found, after all else had failed, that mixing gr. 1 of carbolic acid in ℥j of atropine solution prevented atropism.

In cases of iritis with suppuration the eye should be fomented frequently with hot belladonna lotion and kept bound up with lint soaked in the lotion.

In cases accompanied by much pain blood should be taken from the temples by leeches or the artificial leech. Atropine may give rise to pain by causing dragging upon adhesions, and should be used with caution in cases where its application is attended by much suffering, especially if it have no effect upon the pupil. The eyes should be protected from light by a green shade or protectors until the inflammation has subsided.

Constitutional.—Of *constitutional remedies*, there is none so useful in the treatment of iritis *as mercury*. The drug should be given, in some form or other, so as speedily to affect the system in all cases where inflammatory products are plentifully produced, whether the inflammation be of syphilitic origin or not. A pill containing gr. ij of pil. hydrarg. and gr. ¼ of pulv. opii may be taken three times a day and is a very convenient and effectual mode of administration. Mercurial inunction or vapor baths may be employed if preferred.

If the iritis occur in debilitated states of the system or the inflammation go on to suppuration, tonics, as iron or quinine, should be prescribed, and a plentiful supply of good food given. Should there be much pain, opium must be given; and it is well to prescribe the drug in conjunction with extract of belladonna or hyoscyamus. In rheumatic iritis salicylate of soda in doses of gr. xv to gr. xxx three times a day often does much good.

The results of iritis, should they seriously interfere with vision, require the performance of iridectomy or some one of the operations for artificial pupil. Iridectomy should also be performed in cases of recurrent iritis. The removal of a portion of iris in some manner—probably by preventing dragging on adhesions—has a marvellous effect in preventing recurrences.

Injuries.—The iris may be cut, torn, or bruised, prolapsed through or adherent to the cornea in cases of penetrating wounds of that structure (see "Wounds of the Cornea"), or it may be separated from its insertion to a greater or less extent by concussion without external wound. Any of these injuries are liable to set up iritis, which may possibly be followed by suppuration.

TREATMENT.—The injured eye should be kept carefully bandaged with lint soaked in belladonna lotion; and if much pain is complained of or inflammatory symptoms arise, blood should be freely taken from the corresponding temple, either by leeches or the artificial leech.

As in iritis from other causes, the pupil may become blocked or extensive synechiæ form, requiring operative interference at some later period. (See "Operations on Iris.")

Hyperæmia of Choroid.

Increased vascularity of the choroid is not unfrequently met with, more especially in myopic persons; it should be suspected if a feeling of fulness and tension of the eyes, accompanied by watering and intolerance of light, is complained of.

On examination with the ophthalmoscope increased redness of the choroid (especially of that portion nearest the outer side of the optic disc) and some enlargement of the choroidal vessels can be made out; these changes will, however, very probably be overlooked by an inexperienced observer.

Treatment.—The eyes should be kept carefully at rest, protected from light, cold douches employed, and all positions (as stooping or hanging the head) which cause congestion of the eyeballs carefully avoided; blood may be taken from the temples; and if glasses have been worn, their use must be discontinued. When the more acute symptoms have passed off, any anomaly of refraction must be carefully neutralized by suitable lenses.

Inflammation of the choroid, "Choroiditis," occurs under much the same conditions as iritis; it also plays a prominent part in sympathetic ophthalmia and is not unfrequently associated with inflammation of the iris—"choroido-iritis." Two forms will be commonly met with, simple and syphilitic.

Symptoms.—In all cases of choroiditis more or less loss of transparency will be found. Pain, intolerance of light, impairment of vision, fulness of the veins emerging from the sclerotic in the ciliary region, ciliary redness, dilatation and sluggishness of the pupil, and increased tension of the globe are symptoms often met with in choroiditis, but are by no means characteristic of it. A diagnosis can only be made with certainty by examination with the ophthalmoscope.

The changes seen in the choroid with the ophthalmoscope are, grayish or yellowish patches or spots of exudation surrounded by more or less redness (hyperæmia), and at a later period patches of atrophy. The exudation may occur in one or more large patches or be distributed over the whole or greater part of the choroid in the form of spots, this latter condition being known as "choroiditis disseminata." We know that the morbid changes noticed are in the choroid, from their relation to the retinal vessels which pass in front of and are not obscured by the opacity.

Syphilitic choroiditis (in typical cases) is characterized by the presence in the choroid of yellowish lymph nodules similar to those seen in syphilitic iritis; but, as in the latter disease, typical cases are only occasionally met with, and we must be guided by the same rules in forming a diagnosis. Choroiditis disseminata is syphilitic; the atrophic changes left by it are seen in spots of white and dark dotted about the fundus, often combined with an irregular band of dirty white extending round the optic disc. These changes are frequently seen in the subjects of congenital syphilis; the choroidal disease is in many instances associated with floating opacities in the vitreous and may be looked upon as a certain indication of syphilis.

Choroiditis is frequently associated with inflammation and opacity of the vitreous humor; the retina covering the affected portion of choroid is usually involved in the inflammatory change, and the optic disc may be implicated if choroiditis exist in its vicinity.

Atrophy of the choroid, as above stated, frequently follows inflammation. The ophthalmoscope shows white or dirty white patches, or spots corresponding to the areas previously occupied by inflammatory exudation, caused by destruction of the choroid, allowing the white sclerotic to show more or less plainly through it. The atrophic patches are frequently surrounded by dark borders, from accumulation of pigment which has been displaced by the inflammatory material.

Inflammation of the ciliary portion of the choroid (ciliary body) is known as "cyclitis."

Cyclitis is characterized by redness and swelling of some part or the whole of the ciliary region, with considerable enlargement of the veins of the retina, choroid, and iris, and pain in the eyeball, aggravated by pressure in the ciliary region. Cyclitis may be caused by injury or may depend upon syphilis, inherited or acquired. Softening and shrinking of the globe is very likely to follow, from impairment of nutrition, dependent on interference with the circulation of blood. Suppuration may also take place. Wounds implicating the ciliary region of the sclerotic should always be looked upon as much more serious than those of other portions of the tunic, as cyclitis is frequently set up by such injuries. Cyclitis is not uncommonly associated with iritis—"irido-cyclitis."

TREATMENT.—The treatment of choroiditis should be very similar to that of iritis. Iridectomy does good in some chronic cases or in those in which there is increase of tension of the globe. For the atrophic changes no treatment is of much avail.

Bone upon the Choroid.—Deposits of bone are not unfrequently met with upon the inner surface of the choroid in eyes that have been blind and shrunken for years.

Tubercles in the Choroid.—In cases of general tuberculosis deposits of tubercle have occasionally been met with in the choroid.

Injuries.—The choroid may be injured by foreign bodies entering the eyeball or ruptured by violence without perforation of the tunics.

In the former case (more especially if a foreign body be lodged in the structure of the choroid) inflammation is very liable to follow, the eyeball being eventually lost by suppuration or shrinking. A rupture of the choroid from external violence is attended with more or less hemorrhage, which fills the rent made in its structure with blood and may cause considerable displacement of the retina.

Seen with the ophthalmoscope soon after the receipt of the injury, a rupture of the choroid appears as a more or less elongated blood clot: later the blood becomes absorbed and a white linear figure is left, from the white sclerotic showing through the rent in the choroid. This form of injury is not often followed by destructive inflammation.

TREATMENT.—Injuries of the choroid should be treated in the same manner as injuries of the sclerotic, cornea, or iris, with belladonna lotion, lint, and a bandage.

SYMPATHETIC OPHTHALMIA.

"Sympathetic ophthalmia" is the name applied to a peculiar form of inflammation of the choroid, ciliary body, and iris coming on in one eye in consequence of morbid changes which have previously existed or are still in operation in the other.

The most common causes of sympathetic ophthalmia are injuries of one eye, *especially wounds implicating the ciliary region*, or associated with *lodgment* of a foreign body in the interior of the globe.

Shortly after the receipt of an injury the wounded eye may become affected by keratitis punctata and choroido-iritis of a *markedly adhesive character;* pain more or less severe will be complained of, sight rapidly lost, extensive synechiæ form, the tension of the globe—at first somewhat above par—diminish, and shrinking of the eyeball follow.

At any time during the foregoing changes in the injured eye the sound one may become irritable and painful, and a similar inflammation may be set up in it, leading rapidly to a like result.

TREATMENT.—Where sympathetic ophthalmia has been once established, in all probability irreparable damage will be done; the great point to bear in mind is to prevent its occurrence by *timely extirpation of the damaged globe.* (See "Extirpation of the Eyeball.") Should the disease have become fairly established, little benefit can be expected to result from such extirpation, as the morbid changes will probably continue in the sympathetically inflamed globe in spite of the removal of that primarily affected. The sympathetically affected eyeball (or, if excision have not been performed, both eyes) should be kept carefully bandaged with lint soaked in belladonna lotion; all light should be carefully excluded by using a black bandage and keeping the patient in a darkened room. Pain must be relieved by the same methods as in cases of iritis. Any constitutional treatment that may appear necessary should be employed, and as soon as the acute inflammatory symptoms have entirely subsided iridectomy should be performed. This operation often exerts a very beneficial influence upon the nutrition of the globe (see "Iridectomy"), and should be repeated a second, or even a third, time should the new pupil become (as is very likely to be the case) occluded by inflammatory exudations.

Should suppurative inflammation be set up in one eye, sympathetic changes need not be feared in the other: it is only in the adhesive form of choroido-iritis that sympathetic ophthalmia is likely to occur.

SYMPATHETIC IRRITATION.

It not unfrequently happens that soon after the receipt of an injury to one eye its fellow becomes slightly painful, intolerant of light, and irritable. These conditions may remain unchanged week after week and eventually subside. They make up what is known as "sympathetic irritation."

When sympathetic irritation occurs, we must always watch the injured eye carefully; and if signs of choroido-iritis or keratitis punctata appear in it, it should be immediately excised. If no such symptoms occur, however, its removal is not necessary.

THE VITREOUS HUMOR.

Opacities in the vitreous are frequently met with in cases of myopia, and often as the results of choroiditis.

Inflammation of the vitreous occurs occasionally; it is generally of syphilitic origin or caused by injuries, especially the lodgment of foreign bodies within the globe. Vision becomes misty, and on examination the humor is found to be more or less turbid.

TREATMENT.—Should the inflammation be of syphilitic origin, anti-syphilitic remedies should be employed; should it depend on injury, the eye must be kept bandaged with lint soaked in belladonna lotion and measures taken to subdue the inflammation.

Hemorrhage into the Vitreous.—Occasionally bleeding takes place into the vitreous humor to a considerable extent. Impairment of vision is complained of, usually coming on suddenly, and often during some exertion. Examination with the ophthalmoscope (direct method) shows the vitreous chamber to be occupied by a turbid irregular cloud which floats about as the eyeball is moved, gradually subsides to its lower part when the movements are discontinued, and is stirred up again on the movements of the globe being repeated. The blood becomes absorbed to a greater or less extent in the course of time, but very commonly some permanent opacity is left.

GLAUCOMA.

By **glaucoma** we understand "a series of morbid changes of the eyeball; the most prominent, and apparently the one which causes all the others, being an increase of tension of the globe" (Bader).

The cause of the increase of tension is unknown, but is supposed to result from undue accumulation of the intraocular fluids, dependent on hyper-secretion or deficient removal. Glaucoma is said to be *simple* when the increase of tension progresses slowly and continuously without inflammatory outbreaks; *acute or chronic* when attended by attacks of inflammation.

Simple glaucoma presents no very marked symptoms, its onset being most insidious. It is characterized by gradual decrease of acuteness of vision, with narrowing of the visual field, impairment of the power of accommodation, causing rather rapid increase of presbyopia, sluggishness in the movements of the iris, some dilatation of the pupil, and some apparent haziness of the lens. Increase of tension is probably one of the earliest symptoms, but is very liable to be overlooked until the disease is far advanced and considerable hardness of the globe has taken place. With the ophthalmoscope spontaneous pulsation of the retinal arteries may be seen, or pulsation may be produced by very slight pressure upon the globe. The vessels, especially the veins, are thinner on the surface of the optic disc than in the surrounding retina, and the disc itself may be more or less cupped. The cup of glaucoma is characterized by a bluish appearance of the greater portion of the disc; upon this blue portion the vessels appear very small and indistinct, or they may be quite invisible; the margin of the disc is white, and the large tortuous retinal vessels are seen curling up over its edge and appearing on the surface of the retina at a point not continuous with their course upon the nerve surface. Small hemorrhages may also be met with upon the retina.

Absolute Glaucoma.—Sooner or later, in any form of glaucoma, if relief be not given, the condition known as *absolute glaucoma* is established. The eyeball becomes stony hard, the pupil widely dilated and fixed, the cornea hazy and anæsthetic, the iris and aqueous humor discolored, the anterior chamber shallow, and the lens more or less opaque. A few dilated veins are seen issuing from the globe in the ciliary region; the sclerotic may be somewhat bulged in places and bluish in color, and the conjunctiva is extremely rotten, tearing on any attempt to seize it with forceps. On examination with the ophthalmoscope, all appears dark behind the pupil or a dull-red reflection may be returned from the interior, but no details of the fundus can be made out. All perception of light is lost.

In some cases of acute glaucoma, and almost invariably in chronic glaucoma, the onset of the disease is preceded by premonitory symptoms.

These are, as in simple glaucoma, rapidly-increasing presbyopia and slight increase of tension of the globe, sluggishness and dilatation of the pupil, some apparent haziness of the lens, and narrowing of the visual field.

Besides these, we may find some congestion of the veins emerging from the sclerotic in the ciliary region. There may be periodic attacks of dimness of vision, objects appearing as if veiled by a grayish or yellow mist (London fog); in the later stages we may have a halo around a flame or the appearance of a rainbow, and at times attacks of pain in and about the eyeball.

Acute glaucoma usually commences suddenly with well-marked inflammatory symptoms. The patient will state that he was seized (frequently during the night) with sudden severe pain in the eye; the pain will be described as affecting not only the eyeball, but the whole of the corresponding side of the head, and he will have found that the sight of the painful eye is much impaired or entirely lost. On examination, the eyelids will be found slightly reddened and swollen, the conjunctiva somewhat chemosed, and its vessels, as well as those situated more deeply in the subconjunctival tissue, enlarged. There will be profuse lachrymation, and often much intolerance of light; the aqueous humor will very probably be somewhat turbid. The pupil will be moderately dilated, somewhat irregular and fixed, and the tension of the globe greatly increased.

On examination with the ophthalmoscope, some of the appearances mentioned under "Simple Glaucoma" may be found, but the media will probably be so hazy as to obscure the parts behind, a dull-red reflection being all that can be made out.

The acute symptoms may pass off in the course of a few days or weeks, leaving the eye more or less permanently damaged. Similar attacks may recur, but more frequently the disease relapses into a chronic state.

Chronic glaucoma, the form most commonly met with, is characterized by the occurrence of slight inflammatory attacks associated with temporary increase of dimness of vision and more or less pain in and around the eyeball. On examination, the field of vision will be found to be limited, the tension of the globe increased; and if the patient present himself during an inflammatory attack, the conjunctiva and subconjunctival tissue will be found unduly vascular, the pupil somewhat dilated, and the movements of the iris sluggish.

The loss of vision in cases of chronic glaucoma is attended by symptoms like those of the premonitory stage. Patients complain that their sight is always somewhat misty, that there is an appearance of a bright halo around a candle or other flame, that they see colors resembling a rainbow and often of great beauty, and occasionally flashes of light and fiery circles; the last-mentioned symptoms are, however, common to all forms of retinal irritation. Vision is always worst during the inflammatory attacks and recovers to a certain extent during the remission, never, however, returning to the same condition as before the attack.

The ophthalmoscope shows changes similar to those mentioned under "Simple Glaucoma."

Glaucoma Fulminans.—There is yet another form of glaucoma requiring mention—fortunately, rarely met with. Its principal characteristic is the extreme suddenness and violence of its onset; its symptoms resemble those of acute glaucoma in an aggravated form. This variety of glaucoma is known as *glaucoma fulminans*, and the eye attacked by it may be entirely lost in the course of a few hours. The attack is occasionally accompanied by severe headache and vomiting.

Glaucoma is essentially a disease of the latter half of life, occurring most frequently between the ages of forty and sixty, but occasionally in young adults, or even in children. Glaucoma almost always affects both eyes—not, however, simultaneously, but at more or less considerable intervals.

Diagnosis.—In order to diagnose glaucoma we must be well acquainted with the method of ascertaining the tension of the globe, and also with the use of the ophthalmoscope. (See "Examination of Eyeball," etc.)

We must also remember that the injurious effects of pressure are evidenced earliest in the peripheral portions of the retina, and should therefore very carefully examine the condition of the *visual field* in all suspected cases. (See "Examination of Field of Vision.")

Cases are frequently met with in which great contraction of the visual field has taken place, although central vision is still acute. Another symptom which should lead us to suspect glaucoma is the *rapid increase of presbyopia*. Patients affected by the simple or

chronic forms of the disease are constantly changing their glasses, as they find that those which at first appear to suit become useless in the course of a few months.

Apparent haziness of the crystalline lens is a symptom requiring special attention; otherwise, the surgeon may fall into the fatal error of mistaking chronic or simple glaucoma for cataract and allow the disease to continue until sight is irrevocably lost. In such cases ophthalmoscopic examination will most probably show that there is little or no real opacity of the lens, and this, aided by a careful examination of the tension of the globe and the state of the visual field, will prevent so disastrous a mistake.

Secondary Glaucoma.—Besides the foregoing, we not unfrequently meet with what is known as "secondary glaucoma"—*i. e.*, glaucoma coming on in the course of some other disease, as corneitis, ulceration of cornea, iritis, etc. Glaucoma occurring in young persons is usually secondary. Glaucoma following injury is spoken of as "traumatic glaucoma."

TREATMENT.—Glaucoma can be remedied *by operation alone*. And it is our duty to explain to the patient the nature of his case and to urge upon him most strongly the *necessity* for operative interference.

Patients suffering from glaucoma often evince the greatest unwillingness to undergo an operation: this unwillingness is explained by the fact that during the *remissions* of the disease little or no inconvenience is experienced, and, moreover, even at the time that an attack of inflammation is present the sufferer will be encouraged by the hope that the symptoms will pass off (as they in all probability have done in previous attacks), leaving the eye but little damaged. Nevertheless, we must always bear in mind *that an operation, to be successful, must be performed early*, and must not be satisfied until we have convinced our patient of this. Most patients will readily submit to an operation when one eye has been lost and the disease has commenced in the other.

Several operations have been practised for the relief of glaucoma, but iridectomy and sclerotomy are those which give the best results. Iridectomy and sclerotomy, to be effectual, should be performed as early as possible; as a rule, no good is likely to result from an operation in cases where vision has been reduced to bare perception of light, but in acute glaucoma much improvement may take place even though all perception of light have been lost for some days.

In performing iridectomy for glaucoma we must take care to remove the iris well down to its insertion and to excise a good broad piece (see p. 306); merely cutting away a portion of the iris near the margin of the pupil does no good. The operation is easy enough of performance in cases of acute glaucoma, but in those of old standing, where the structures are rotten or the pupils so widely dilated that the iris has become a thin rim at the periphery of the anterior chamber, it is anything but simple. In such cases sclerotomy is to be preferred to iridectomy.

In cases of glaucoma where for any reason an operation does not seem advisable we must do our best to give relief by medical treatment. The means which will be found most useful are the instillation of solutions of sulphate of eserine (gr. ij to iv to water ʒj), application of sedative fomentations, administration of opium, and the local abstraction of blood by leeches or the artificial leech.

Atropine *should not be used* in glaucoma, as it causes increased vascularity of the globe, and with it augmentation of tension. Its application is recommended in most works on ophthalmic subjects, but it does more harm than good. Eserine, however, has a contrary effect and is often of great benefit.

THE RETINA AND OPTIC NERVE.

Vision.—Space will not allow of a detailed account of all the anomalies of vision which may be met with. Before the introduction of the ophthalmoscope all cases of *want of sight* occurring without cause apparent to the unaided eye were collected together into two classes bearing the names "amblyopia" and "amaurosis."

Amblyopia and Amaurosis.—To the former were referred all cases where the vision was much impaired, but not entirely lost; to the latter, cases in which not even perception of light remained. But, now that the ophthalmoscope has come so generally into use, making the interior of the globe as accessible to our sight as the exterior, we have come to refer "amblyopia" and "amaurosis" to their proper causes, and the terms have fallen into comparative disuse. For instance, if in a case of want of sight we find on ophthalmoscopic examination that there is haziness of the vitreous, inflammation of the retina, etc., we do not say (as formerly) that the patient is "amblyopic," but that he

is suffering from opacity of the vitreous, retinitis, etc. Again, in cases of total blindness, the ophthalmoscope will in all probability detect atrophy of the optic nerve or other lesion, and, instead of saying that the patient is "amaurotic," we say that he is suffering from atrophy of the optic nerve, etc. The terms "amblyopia" and "amaurosis" may, however, still be used in some rare cases where there is a partial or complete loss of sight associated with an apparently healthy condition of all the ocular structures.

Hyperæmia of the retina occurs from overstrain of the eyes in doing near work (especially in hypermetropic or astigmatic persons) or from constantly looking at bright light; the disease is not uncommon amongst engine-drivers and others who work over a blazing fire.

The patient complains of some dimness of vision and a feeling of fulness and discomfort in the eyes. On examination with the ophthalmoscope, the retinal vessels, both arteries and veins, will be found increased in size, and a greater number of each will be visible than in the healthy retina.

This form of hyperæmia may be described as "active;" another form of hyperæmia, affecting only the retinal veins, which become enlarged, tortuous, and sometimes varicose, may be described as "passive;" this condition is indicative of obstruction to the return of blood from the eyeball. (See "Ischæmia.")

Hyperæmia of the retina, especially the active form, is not easily recognized, as the limits between health and disease fade almost imperceptibly into each other, and considerable experience is required in order to judge with certainty where one ends and the other begins.

Treatment.—Active hyperæmia should be treated by rest, carefully shielding the eyes from bright light by means of neutral-tint protectors or a shade. After the subsidence of the hyperæmia any anomaly of refraction should be carefully neutralized.

Passive hyperæmia is usually an indication of some more serious disease, and requires no special treatment.

Inflammation of the Retina (retinitis).—Retinitis most frequently depends on some constitutional condition, as albuminuria or syphilis; it may also arise from embolism of the vessels of the retina, hemorrhage into its substance, or from cerebral disease; from tumors or entozoa within the globe, exposure to sudden flashes of bright light, or wounds of the eyeball. It may also be secondary to choroiditis, iritis, or cyclitis.

Retinitis is characterized by hyperæmia of the retina associated with more or less dense and extensive opacity of its structure, and frequently with extravasations of blood in its substance.

Disturbance of vision may be a prominent symptom, or the patient may hardly be aware that anything is amiss with his eyes. The degree of impairment of vision depends upon the situation and extent of the inflamed portion of the retina; for instance, a small patch of inflammatory exudation in the region of the yellow spot will cause much loss of sight, whereas a considerable amount of opacity situated peripherally will give rise to scarcely any symptoms.

Pain, photophobia, colored vision, and flashes of light are symptoms occasionally met with in inflammation of the retina.

Acute retinitis is rarely met with, and if it should occur would hardly be recognized, as the inflammatory exudation would be transparent, and therefore invisible; consequently, the only appearance revealed by the ophthalmoscope would be enlargement and tortuosity of the retinal vessels.

The forms of retinitis which give rise to striking ophthalmoscopic appearances are essentially of a chronic nature and are frequently associated with inflammatory changes in the choroid and optic nerve.

Retinitis may affect one or both eyes, those forms which are of constitutional origin usually affecting both, though not always in the same degree. Several varieties of retinitis are described.

Simple Retinitis.—The ophthalmoscope shows a more or less general turbidity of the retina, varying from a scarcely perceptible cloudiness (giving the idea that the structure is colored and visible instead of entirely transparent) to a uniform grayish-white or mottled opacity, which appears to cover the choroid like a veil.

The outline of the optic disc is indistinct. The retinal veins appear enlarged, dark-colored, evidently gorged with blood, often twisted in their course, and they may be in parts hidden by the inflammatory exudation. The condition of the arteries is nearly normal, or they may appear too thin.

Small hemorrhages are frequently detected in the course of the distended veins.

Hemorrhagic Retinitis.—The optic nerve will be found reddened, somewhat swollen, its outline obliterated, its transparency so much affected that the course of the retinal vessels upon its surface and in its substance cannot be traced; the retinal veins are turgid and tortuous in their course, presenting alternately light and dark portions, according as they lie deeply in the engorged retina or more superficially near its inner surface. The retinal arteries, as in the simple form of retinitis, are nearly normal or too thin.

The principal characteristic of the disease is the occurrence of extensive hemorrhage, most marked around the optic disc, and fading away gradually into the surrounding parts. The blood extravasations have a peculiar striated appearance, and radiate spoke-like from the optic disc as a centre. In some cases the retina immediately surrounding the disc is uniformly soaked with blood, the bright-red color thus produced gradually shading off externally into the spoke-like appearance above mentioned.

As time goes on the extravasated blood undergoes changes, becoming brown in color, and eventually partially or entirely absorbed.

Retinitis pigmentosa is a peculiar form of degeneration of the retina met with most frequently in the offspring of blood relations; the sufferers are often deaf and dumb, and may be partially idiotic.

The most marked symptoms of the disease are *night blindness* and *gradual narrowing of the visual field without glaucomatous symptoms.* The ophthalmoscope reveals the most striking changes: the retina, more especially about its peripheral parts, is dotted more or less thickly with black-pigment spots; these spots appear somewhat like a multitude of small black spiders with many legs; they have also been likened to bone corpuscles. The spots of pigment appear to follow the course of the blood vessels of the retina, and, as before stated, are collected most thickly in its peripheral parts.

The blood vessels themselves are much diminished in size and visible number and the optic disc is markedly anæmic.

Albuminuric retinitis is a peculiar form of retinitis met with in Bright's disease. The changes which take place in the retina are inflammation with effusion and hemorrhages, followed by fatty and fibrinous degeneration of its structure, and subsequent atrophy.

The ophthalmoscope shows, in the early stages of the disease, retinal hyperæmia (more especially venous) with increased vascularity and redness of the optic disc. Next the retina becomes cloudy (more especially around the optic disc, the outline of which becomes obscured), and numerous hemorrhages in the form of streaks and spots occur in various parts of its structure.

The cloudiness goes on increasing and obscures the smaller vessels; later, in different parts of the fundus, but mostly in a ring situated at a little distance from the margin of the disc, appear glistening white spots and patches; later the disc itself becomes gray and opaque.

Whilst the above changes are going on in other parts of the retina characteristic appearances may be developed in the region of the yellow spot. A number of small white glistening spots—which, however, do not coalesce so as to form a patch, but remain distinct—make their appearance. These glistening spots are arranged in a somewhat radiated position around the macula as a centre and somewhat resemble a constellation; the appearance is quite characteristic, and, once seen, is not likely to be forgotten.

As the opacity of the retina increases the vessels become more and more obscured, so that when the disease has reached its height only a few large venous trunks are still visible. Fresh hemorrhages may occur at any time and cover over and obscure the opaque portions of retina. After a time a retrograde process sets in: the hemorrhages and peculiar opacities slowly disappear, the retina being at length left in a state of atrophy. Displacement of the retina may occur.

Albuminuric retinitis is usually associated with granular kidney; it is dependent on the blood-vascular disease (arterio-capillary-fibrosis, Gull and Sutton) of which the kidney affection is only a part. The retinitis often appears before any sign of the kidney mischief is manifested, and it is the ophthalmic surgeon who first discovers the nature of the case.

Leucæmic Retinitis.—A peculiar form of retinitis somewhat resembling the albuminuric has been described as occurring in connection with leucocythæmia.

Leucæmic retinitis is marked by pallor of the optic disc, a peculiar rose-color of the retinal vessels, hemorrhages, some opacity of the retina around the optic discs, and white glistening spots similar to those met with in albuminuric retinitis, which, however, are situated in the peripheral parts of the retina.

Embolism of the Retina.—A form of retinitis associated with plugging of the central artery comes on suddenly without apparent cause, with complete loss of sight. Ophthalmoscopic examination shows some pallor of the optic disc and diminution in calibre of the vessels emerging from it, but the most marked change is seen in the region of the yellow spot.

The retina around the spot is gray and opaque, and numerous blood vessels not visible under ordinary conditions come plainly into view; the macula itself is seen as a bright-red spot (which might be taken for a hemorrhage by a careless observer) situated in the centre of the opaque portion of retina.

The bright-red appearance of the macula arises from the anatomical arrangement of the parts; the retina in this situation, being thin and firmly bound down to the parts beneath, does not become infiltrated with inflammatory exudation, and consequently the normal red color of the fundus appears in striking contrast to the surrounding opaque retina. Hemorrhages may occur.

Syphilitic Retinitis.—A form of inflammation affecting the retina immediately surrounding the optic disc has been looked upon by some as of syphilitic origin, but, like syphilitic iritis, rarely presents any very characteristic signs. Should retinitis occur with other manifestations of syphilis, congenital or acquired, it may be looked upon as syphilitic.

TREATMENT.—Both eyes should be kept thoroughly at rest by prohibiting all near work, paralyzing the accommodation by atropine, and shielding the eyes from the stimulus of too bright light by neutral-tint protectors. Everything that is likely to cause disturbance of the ocular circulation, as stooping positions, excitement, stimulants, too rapid variations of temperature, etc., should be carefully avoided.

In simple retinitis blood should be taken from the temples by leeches, or, preferably, by the artificial leech, and in this form, as well as in retinitis connected with syphilis, mercury does good; it should be given so as quickly to affect the system either by the mouth, by inunction, or in the form of vapor baths. In cases of long standing, however, small doses of the bichloride of mercury, taken regularly for some months, may be beneficial. The other forms of retinitis are of only secondary importance to the disease with which they are associated, and against which treatment must be directed. (See "Causes of Retinitis.") No treatment is of much avail in retinitis pigmentosa.

Atrophy of the retina may be the sequel of inflammatory changes. Its principal characteristic seen with the ophthalmoscope is a condition of bloodlessness, in some cases associated with opacity of the retina and frequently with atrophic changes in the choroid. Bloodlessness shows itself in a diminution of the visible number, and also of the calibre, of the retinal blood vessels, more especially of the arteries, some of which may appear pervious to red blood corpuscles in part of their course only, their continuations being marked by a yellowish-white cord. Opacities, if they occur, are of a grayish-white color and situated for the most part around the optic disc.

The disc itself is frequently extremely anæmic or atrophied. (For treatment of atrophy of the retina, see "Atrophy of the Optic Disc.")

Hemorrhage into the Retina.—Besides the form of hemorrhage described as occuring in retinitis, bleeding may take place into the structure of the retina from rupture of a retinal blood vessel without previous inflammatory change. The hemorrhage is usually considerable, and will be seen as an irregular patch of blood situated somewhere in the course of the ruptured vessel, and often surrounded by inflammatory exudation.

The extravasated blood becomes gradually absorbed, but usually leaves behind it some indications of its previous existence.

TREATMENT.—Rest of the eyes, protection from bright light, and blisters to the temples.

Displacement of the retina is associated with effusion of serous fluid between it and the choroid; it may be caused by blows on the eyeball or the head in its vicinity; it may occur without apparent cause and is often met with in myopic eyes. Displacement of the retina occurs by preference at its lower part, but may vary in extent from detachment of a small fold to total separation of the whole retina from the choroid, the only points of attachment left being at the optic disc and ciliary processes.

The ophthalmoscope shows a gray, opaque, movable cloud, over the surface of which the retinal blood vessels can be traced.

TREATMENT.—Little can be done to remedy displacement of the retina, but an attempt should be made to procure absorption of the fluid by the administration of such drugs as iodide of potassium and mercury, and by the application of blisters to the tem-

ple. If the displacement occur in connection with myopia, the anomaly of refraction should be carefully neutralized by suitable glasses; and in all cases rest should be ensured to the eyes, so as to prevent, as much as possible, further detachment.

Inflammation of the Optic Disc (optic neuritis, neuro-retinitis).—The ophthalmoscope shows a reddish-gray turbidity of the disc and the surrounding zone of retina, accompanied by swelling of the parts. The retinal veins are engorged, but their visible number is not increased; the arteries are thinner than usual, and all the vessels are more or less shrouded and concealed from view in the opaque portion of retina and upon the nerve surface. Numerous small hemorrhages may occur upon the disc and around it.

Ischæmia of the Disc (choked disc).—Choking of the optic disc has been (and still is by some) looked upon as distinct from optic neuritis. It would, however, appear that the difference is one of degree only. The ophthalmoscope shows great swelling and an intense red color of the disc, its outline being entirely lost; there is, however, but slight swelling or opacity of the surrounding retina; small hemorrhages are frequently seen on the nerve surface. The retinal veins are enormously distended, their course extremely tortuous, and they may be varicose; their visible number is also considerably increased. The arteries are thinner than natural or of normal calibre; none of the vessels are shrouded and concealed from view as in neuritis. Ischæmia may go on to neuritis.

In many cases of neuritis and choked disc sight is unaffected; in others, vision is much impaired or reduced to perception of light only.

Optic neuritis and ischæmia may be looked upon as indicative of irritation of the nerves in some part of their course, as would occur in meningitis, or of obstruction to the venous circulation resulting from pressure directly on the main trunks, as in cerebral tumor, or from any form of disease whatever which causes *overcrowding* of the contents of the cranium. Both neuritis and ischæmia are usually bilateral.

Treatment.—Optic neuritis and ischæmia of the disc are of only secondary importance to the disease which gives rise to them; they are of much greater interest to the physician than to the oculist, as their existence enables him to diagnose cerebral lesion with great certainty. The cerebral lesion is, however, often syphilitic; and it may be laid down as a rule seldom to be departed from that optic neuritis and ischæmia call for the administration of iodide of potassium or mercury in full doses.

Atrophy of the optic nerve may be the result of preceding neuritis, when it is called "consecutive atrophy," or the atrophy may have commenced as such and slowly progressed without inflammatory change—"simple atrophy."

With the ophthalmoscope the optic disc will be seen to be white or bluish-white in color; frequently its margin appears irregular and it may be cupped. The atrophic cup varies from the glaucomatous in not having steep sides, so that the vessels do not appear broken in their course, as in the latter affection; it does not take in the whole nerve, but only its central part, which slopes gradually backward; the vessels appear curved on the surface of the disc, but are not altered in calibre, as in glaucoma. Atrophy of the retina frequently goes along with atrophy of the optic disc.

In cases of atrophy of the optic nerve vision is always much impaired; some patients with extremely white discs can count fingers, distinguish large letters, or even read ordinary print, but in the majority of cases vision is reduced to a bare perception of light.

Treatment.—The treatment of atrophy of the optic nerves, especially if associated with a similar condition of the retina, is most unsatisfactory, and, indeed, almost hopeless. Should a certain amount of vision still remain and no change have taken place for many months, we may safely assure our patient that he will retain what sight he has. The drugs which have been principally used are iron, either alone or in combination with nux vomica, strychnia, taken by the mouth or injected hypodermically, phosphorus, quinine, or other tonics, and opium in gradually increasing doses. Galvanism has also been employed.

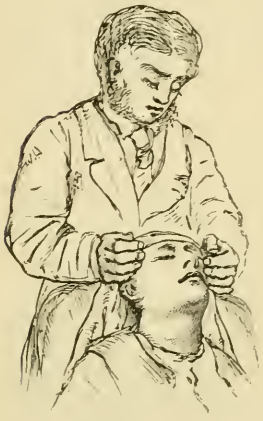
OPERATIONS ON THE EYEBALL AND ITS APPENDAGES.

POSITION OF THE PATIENT AND OPERATOR, ETC.

All the minor operations, such as slitting the canaliculi, passing probes down the nasal duct, opening tarsal cysts, etc., can best be performed when the patient is seated in a chair and the operator stands behind him, the patient's head, over which a towel has first been thrown, resting against the operator's chest. (See Fig. 110.)

The more important operations, as extraction of cataract, iridectomy, squint, etc., should be performed whilst the patient is lying on a hard couch, his head resting on a bolster covered by a towel, which should be thrown forward over the forehead; the operator should sit or stand behind. (See Fig. 111.) In whichever position an operation is to be performed, the chair or table should be placed in front of a large window, so as to ensure a good light, and care be taken to prevent assistants and others from interposing their heads or bodies between the patient's face and the source of light. It will be found whilst operating that, with the exception of occasional pronation and supination, there is little occasion to use the arms, which should be kept with the elbows near the sides, the wrists resting on the patient's head or face in a position which allows of free movements of the hands and fingers.

Fig. 110.



Position for Minor Operations. (Sitting.)

Fig. 111.

Position for Major Operations. (Lying.)

Every ophthalmic surgeon should learn to use his fingers, cultivate his sense of touch, and, if possible, become ambidextrous.

It will be found that incisions can best be made by holding the knife lightly between the thumb and first two fingers of whichever hand is most conveniently situated.

In all operations incisions commencing at or situated entirely on the outer aspect of the globe should be made with the hand corresponding to that side, the opposite hand being employed upon the inner side. That is to say, if the right eye is operated on, the right hand should be used to make an incision at its outer side, the left at its inner, and *vice versâ*.

Incisions above or below may be made with either hand; scissors should also be used with whichever hand is most favorably situated.

In one operation—that for internal strabismus—the positions of patient and operator are somewhat different from those already described, the operator standing in front, at the side of the couch on the patient's right, instead of behind his head.

The scissors may be used with the right hand for both eyes, but in operating on the left the hands will have to be crossed.

Before performing any operation the operator should look carefully to the condition of the instruments he is about to use. Knives should be passed through a piece of thin leather tightly stretched on a small metal cylinder, and care taken to ascertain that they have good points and that there are no notches in the blades.

Scissors should be carefully examined and tried; it should be seen that forceps close perfectly and are free from rust or dirt; silk for sutures should be black, as fine and strong as possible, well waxed, and free from flaws or kinks. Inattention to these details may very possibly mar the success of an operation.

Administration of Anæsthetics.—The operator will find that he has much more command over the eye when the patient is under the influence of an anæsthetic than when consciousness remains, and in by far the greater number of cases he will do well to administer one.

Occasionally patients are met with who will bear operations most quietly: such should

be operated on without anæsthesia; but if during the operation the patient become unsteady or begin to strain, it is best not to risk failure, but to discontinue the operation and administer an anæsthetic. If the globe has been opened, it must be carefully guarded by a pad and bandage during the administration. If no anæsthetic be employed, the operation should be performed as simply and quickly as possible; no speculum should be used, nor should the eye be fixed with forceps, but the operator should keep the lids open and steady the globe with the fingers.

After-Treatment.—Operations on the tear passages, removal of tarsal cyst, and strabismus require little or no after-treatment; the parts need only to be washed twice or three times a day with tepid water.

After more severe operations on the eyelids, and in all cases where an incision has been made into the globe, the eye should be carefully covered with two small folds of lint wetted with cold water and secured by a single turn of bandage, the lint being kept wet and the eye bound up until the incision has healed and all irritation subsided. Wounds of the globe made in operations, as a rule, heal rapidly, union having frequently taken place at the end of twelve hours.

The great danger after operations on the globe is the occurrence of inflammation.

Occurrence of Inflammation.—Inflammation, once set up, may subside shortly, leaving no trace behind it; it may continue until more or less irreparable damage has been done, or may run on to suppuration of portions or the whole of the globe. The cornea is more liable to this change than any other structure.

The symptoms of inflammation usually appear within the two days immediately succeeding an operation, and little fear need be entertained for the safety of the eyeball if all has gone well for a week.

Occasionally, after cataract extraction, eyes have been lost through inflammation, or suppuration commencing at a later period; but these cases are rare, and probably it will be found that some damage has been done to the eye shortly before the symptoms appeared.

The treatment of inflammatory changes consists in the local abstraction of blood from the temple by leeches or the application of the artificial leech; the use of fomentations of water, poppy-heads, or belladonna constantly applied; the administration of opium in full doses, either alone or combined with mercury. The treatment must, of course, be varied according to the condition of the patient: should he be weakly and anæmic, we should be careful about blood-letting, and, instead, quinine and iron, with good living and a fair amount of stimulants, should be prescribed.

The local abstraction of blood, however, acts most beneficially in relieving pain, and should, therefore, be employed in cases where pain is a prominent symptom, even though the patient does not appear to have much blood to lose. Strong, healthy patients should be leeched freely and kept on light diet.

During the treatment the eye must be kept carefully closed and bandaged, excepting during the time that fomentations are being applied. Moderate pressure by carefully-applied pads of lint and cotton-wool secured by a few turns of flannel bandage is said to exert considerable influence in cases where the cornea is threatened by suppuration; it should have a fair trial if pressure can be borne.

If the inflammation go on to suppuration of the whole globe, the case must be treated in the same manner as abscess in any other part. (See "Ophthalmitis.")

Insertion of a Seton in the Temple.—In order to place a seton in the temple, the position of patient and operator should be as in Fig. 110, p. 290. The operator should pinch up the skin with the finger and thumb of one hand just in front of the patient's ear and pass a seton needle armed with a double thread of stout silk through the fold thus produced; the silk should be drawn through and tied in a short loop. The seton should pass for about 1½ inches beneath the skin, and should be placed amongst the hair, so as to avoid, as much as possible, disfigurement from the subsequent cicatrix: the silk should be drawn backward and forward through the wound every morning; it may be left in as long as appears necessary.

Care must be taken in passing the needle not to wound the temporal artery: should this accident happen, the seton must be removed and firm pressure applied with a pad and bandage.

Application of the Artificial Leech.—This instrument consists of a small sharp steel cylinder (worked by a spring arrangement), with which a circular incision can be made through the skin of the temple, and a hollow glass cylinder, which can be placed over the wound and the air in its interior exhausted by means of a piston worked

by a screw; as the air is removed the blood flows up to fill the vacuum. Care must be taken not to work the screw too quickly, but only to move the piston at the same rate as the blood flows; neither must the edge of the cylinder be allowed to compress the skin against the parts beneath, otherwise the flow of blood will be impeded.

THE EYELIDS.

Tumors.—Various small growths are met with about the eyelids.

Molluscum occurs as a small yellowish-white projection, having a depressed and often blackened centre, situated on some part of the skin of the lids; there may be only one or many of these little growths. They can be easily removed by thrusting a knife through them and then squeezing out the contents with the thumb-nail.

Dermoid cysts are not unfrequently met with situated deeply beneath the skin and the muscle, often near the outer angle of the orbit. They are congenital, filled with sebaceous matter, and often contain hair. They must be carefully dissected out, much more trouble being experienced in so doing than would be at first suspected; and they will in all probability be opened during removal. These little tumors will be found attached deeply to the periosteum, and may have caused a depression in the bone.

Warts are not unfrequently met with about the eyelids; they should be cut off with scissors.

Tarsal cyst is met with as a dusky-red or colorless projection from the outer surface of the lid; its position is marked on the conjunctival surface by a bluish spot, from which a granulation is occasionally seen growing. The cyst is formed by obstruction of a Meibomian gland and retention of its secretion; it is sometimes in a suppurating condition.

The lid should be everted, the cyst freely opened from the conjunctival surface with a small knife, and its contents squeezed or scooped out; it must be thoroughly emptied, or it will in all probability re-form.

The cavity left on removal of the contents of the cyst will always fill with blood, and shortly after the operation the tumor will be as large as, or larger than, before; the patient must be warned of this.

The swelling will most probably disappear in the course of from four to six weeks; if it remain longer, the operation should be repeated.

A tarsal cyst sometimes degenerates into a hard fibrous little mass, feeling somewhat like a large shot beneath the skin, which is known as a *chalazion;* this should be dissected out through an incision in the skin of the lid, which should afterward be closed by a fine suture.

Xanthelasma is often met with as a small yellow patch on some part of the skin of the eyelids; its most frequent site is the surface of the upper lid, near the inner canthus. The little patch may be excised if it is a source of anxiety to the patient.

Simple serous cysts occur about the margins of the lids; they are about the size of small peas and nearly transparent. A portion of the cyst wall should be cut out with scissors.

Trichiasis signifies a faulty direction of the eyelashes, which turn inward and irritate the cornea; it is usually caused by contraction of the conjunctiva (following granular ophthalmia or its unskilful treatment), producing displacement of the hair *follicles.*

Treatment.—Only a few lashes may be misdirected, or the whole row may be inverted. If only a few of the lashes turn inward, it is sufficient to pull them out with forceps whenever they become troublesome. If a considerable number or the whole row are inverted, their roots should be removed by operation. The operation should be performed as follows: The patient being placed in the usual position (see Fig. 111, p. 290), the lid should be secured by a compressorium forceps (Figs. 112, 113), by which means it is steadied and hemorrhage prevented; care must be taken not to screw the instrument up too tightly, or sloughing of the lid may follow. The lid being well secured, the operator should make an incision through the skin, about three lines from the free margin of the lid and parallel with it, of such a length as to correspond to the lashes which are misplaced; the incision should be carried down to the outer surface of the tarsal cartilage; a second incision should then be made of the same length as the first, in the margin of the lid, and so conducted as to split the lid and separate the skin and hair-bulbs from the subjacent structures; the ends of the two incisions should then be joined by two short cuts, and the portion of skin included with the hair-bulbs dissected off the tarsal cartilage. The raw surface should then be wiped with a sponge and any black dots

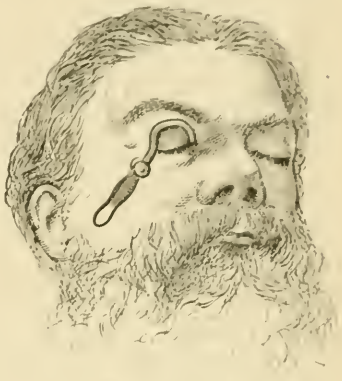
denoting the presence of hair-bulbs carefully removed. The compressorium forceps should then be unscrewed, when sharpish hemorrhage will take place. The eye must be covered by two pieces of wet lint secured by a turn of bandage.

Entropion signifies a rolling inward of the whole lid, the whole row of lashes being completely turned toward the eyeball; it is most frequently met with in the lower lid, more especially in old people with a superabundance of loose skin about the face. It is often the cause of much trouble and annoyance, as well as of danger to the eye, after cataract extraction.

Fig. 112.

Compressorium Forceps.

Fig. 113.



Compressorium Forceps Applied.

The inversion may be caused either by spasmodic contraction of the orbicularis muscle or by distortion and thickening of the tarsal cartilage after granular ophthalmia.

Entropion caused by contraction of the orbicularis is easily remedied as follows: The patient lying on a couch (see Fig. 111, p. 290), the operator should seize with forceps the skin of the lid at a point near one or other canthus, about two lines from its margin, and then with scissors remove a portion in breadth corresponding to about half the surface of the lid and extending along its whole length; he should then seize and remove the orbicularis muscle to a corresponding extent; no suture need be used; the eye should be bound up with wet lint and a bandage. The subsequent healing of the wound and contraction of the cicatrix will remedy the inversion.

Entropion depending on distortion and thickening of the tarsal cartilage is usually met with in the upper lid. It can be remedied by removal of a wedge-shaped piece of cartilage, including the more thickened portion, by the following operation: The patient being in the usual position (see Fig. 111, p. 290) and the lid fixed by a compressorium forceps, with a sharp knife an incision should be carried through its whole thickness, parallel with and about two lines distant from its margin, along the whole extent of the thickened portion. A somewhat lunated incision should then be made from one end of the first around the base of the thickened portion of tarsus, joining the first incision at its other extremity; the second incision should not be carried vertically through the cartilage, but obliquely, so as to meet the first at the conjunctival surface; the portion of cartilage included between these incisions should then be removed, the wound closed by sutures, and the eye bound up with lint and a bandage. The skin and muscle covering the cartilage may be removed or not, according to the fancy of the surgeon. If their removal is not desired, they should be dissected back before making the second incision. After the operation the margin of the lid should appear rightly directed.

Ectropion signifies an everted condition of the lid; the extent of eversion varies in different cases, from slight falling away of the margin of the lid from the globe to eversion of the whole extent of the lid and adjoining fornix of the conjunctiva.

The slighter forms are caused by distension of the lid from inflammatory swelling, and are easily remedied by slightly narrowing the palpebral aperture by paring the edges of the lids near the outer canthus, and bringing the raw surfaces together by a suture, when firm union will take place between the two.

The more extreme forms are caused by the contraction of cicatrices of burns, wounds, or inflammatory changes, about the orbit.

No definite rules can be laid down with regard to the treatment of these cases. The surgeon must be guided by the conditions as they present themselves, and do the best he can.

In any case, if the tarsal cartilage be left entire, it should be carefully dissected away from its attachments and replaced as nearly as possible in its normal position, in which it must be kept by paring its margin and that of the opposite lid and securing extensive and firm union between them by careful coaptation of their raw surfaces. The lids must

not be opened until all further contraction of the original cicatrix is at an end, and it is better to leave the eye closed for considerably too long a period than to open it a day too soon. Ectropion is also frequently seen in the more severe forms of ophthalmia or in cases of severe intolerance of light, and is specially liable to occur when an attempt is made to open a firmly-closed eye. In these cases the eversion requires no special treatment, but disappears as the affection causing it is recovered from.

Formation of a New Eyelid.—In some cases of burn or from ulceration of a lupoid character more or less complete destruction of the eyelids may take place. To remedy this defect, a flap of skin from a neighboring part may be brought, placed in the gap, and there secured by means of sutures, care being always taken that the piece of skin is considerably larger than the surface it is intended to cover. Before removing any skin search must be made in any portion of the eyelid that may be left for the tarsal cartilage, and if this be found it must be carefully dissected out and preserved, its natural form being as much as possible restored; it should be fixed in its proper position by uniting its margin to that of the opposite lid. Even if no flap of skin be applied over it, it will in time become covered with cuticle and form a very effectual covering to the eyeball.

Symblepharon signifies adhesion of the conjunctiva of the eyelid to that of the globe. It is usually caused by burns with lime or hot metal, and may occur to any extent, varying from a thin band of union to fusion of the greater part or whole of both lids with the globe.

This condition requires to be remedied by operation. Where only a thin band of adhesion exists, it should be first carefully secured by a suture passed through the extremity nearest the eyeball, and then be divided and drawn into the fornix by passing the suture through the lid and securing it to a small roll of strapping placed upon the cutaneous surface. By this means the raw surface left by removal of the band from the globe is brought into contact with healthy conjunctiva and granulates over, healing without forming adhesions.

If more than one band exist, each should be dealt with separately.

Cases of more extensive adhesion give rise to the utmost difficulty in treatment, and until lately the operations performed for their relief were attended with only indifferent success. One plan of treatment recommended was to dissect away the adhesion and interpose a shell of glass between the raw surfaces, but, as healing invariably commenced at a point remote from the free margin of the lid, the shell was gradually pushed out and the adhesion re-established.

The insertion of pieces of wire deeply beneath the adhesion, which were left in until the walls of the canal made by them had healed, the remainder of the adhesion being then divided with scissors, was followed by no more satisfactory results.

Lately an operation has been introduced by Mr. P. Teale of Leeds which has been attended with the best success. The operation has for its object the separation of the raw surfaces by a piece of conjunctiva taken from some other part of the eyeball. The following is an extract from the account of the operation given by Mr. Teale in the *Transactions* of the Fourth Ophthalmic Congress, 1872:

"The patient being under the influence of an anæsthetic, the eyelid is freed from its attachment to the lid; next, a band of somewhat circular form is marked out with a sharp knife upon the sound conjunctiva; the band commences at one end of the gap left by liberation of the lid and passes round the sound side of the cornea, terminating at the opposite extremity of the gap.

"Four stitches are then inserted, two on each edge of the flap thus formed. The flap is next separated on its *under surface*, whilst its extremities are left continuous with the conjunctiva; it is then drawn across the surface of the cornea and fixed, raw surface downward, into the gap formed by the liberation of the eyeball from the lid; it is secured in its new position by the sutures already alluded to, aided by as many others as may appear necessary."

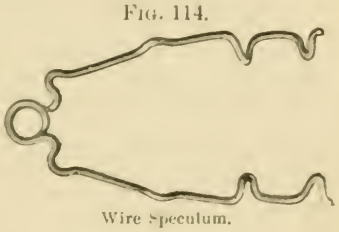
Mr. Teale states that "the operation is most tedious," and that he rarely completes it within the hour.

Anchyloblepharon signifies an adhesion of the lids to each other. The adhesions must be divided with scissors, and if possible some skin or conjunctiva interposed between the raw surfaces; but if this cannot be done, reunion may be prevented by passing a probe between the lids daily.

Narrowing of the palpebral aperture (Blepharophymosis) is usually a result of granular ophthalmia, and is accompanied by entropion, displaced tear puncta,

and consequent watering of the eye. It requires to be remedied by operation, which can be thus performed: The lids being kept widely open and on the stretch by a wire speculum (Fig. 114), an incision should be made with strong scissors through the outer canthus. A flap of conjunctiva of somewhat conical shape should then be marked out on the surface of the eyeball, the flap freely dissected from the subjacent structures, but left attached at its base, which is toward the cornea, and then fixed by sutures in the incision made by the scissors, in such a manner as to keep the raw edges separated by a mucous surface.

Fig. 114.



Wire Speculum.

It is sometimes necessary to narrow or close entirely the palpebral aperture. This operation, known as *tarsoraphy*, can be performed as follows: The lid being held with forceps, a portion of *the inner edge* of its margin should be removed with a small iridectomy knife, care being taken not to cut away any of the outer edge containing the lashes, nor to wound the tear puncta or canaliculi. The opposite lid should then be treated in the same manner and the raw edges brought together by sutures; firm union will soon take place between them.

Ptosis signifies a drooping of the upper eyelid to a greater or less extent, with inability to raise it. Ptosis occurs with divergent strabismus and more or less impairment of the mobility of the eyeball in cases of paralysis of the third nerve, and is generally, but not invariably, accompanied by dilatation and fixity of the pupil.

It is also met with as a congenital defect, and occurs sometimes after severe inflammation of the lid or protracted intolerance of light and constant spasmodic action of the orbicularis muscle. Women past the middle period of life with a superabundance of loose skin about the face are also subject to a form of partial ptosis.

Treatment.—In ptosis from paralysis of the third nerve treatment must be directed against the cause of the paralysis, no operation being advisable; other forms can be remedied by the removal of some skin and orbicularis muscle from the surface of the lid.

The operation may be performed as follows: The skin at the upper part of the lid should be pinched up with forceps, the amount included between their blades being such as to raise the margin of the lid well above the upper border of the pupil. Then with scissors a strip of skin of the required width should be removed, along the whole extent of the lid, parallel to its margin; the orbicularis muscle should then be cleanly dissected off the tarsal cartilage to about the same extent, the wound closed by one or two fine sutures, and the eye bound up with wet lint and a bandage.

The wound will heal in the course of a few days, and the shortening caused by the removal of the skin and muscle and subsequent cicatrization (possibly aided by the entanglement of some fibres of the occipito-frontalis in the scar) should keep the lid in the desired position.

In cases of congenital ptosis we often find movement of the eyes upward greatly impaired; it seems probable that the superior rectus is badly developed or altogether absent.

THE LACHRYMAL APPARATUS.

The lachrymal gland is occasionally the seat of malignant or other growths and may require extirpation.

A cyst is sometimes met with caused by obstruction of one of the ducts of the gland and accumulation of secretion. The disease is known as *dacryops*.

Treatment.—Its treatment consists in establishing an opening into it from the surface of the conjunctiva; this is easily done by passing a curved needle armed with silk from beneath the upper lid through the wall of the cyst into its cavity, and out again at a convenient distance; the silk should then be drawn through and the portion of cyst wall included between the entrance and exit of the needle firmly ligatured; the ligature will slough out and leave a permanent opening, causing no inconvenience. If the cyst be opened through the skin, it may leave a troublesome fistula.

The Tear Puncta and Canaliculi.—The tear puncta in the normal condition lie in contact with the ocular conjunctiva; they may be either everted, as seen in old and neglected cases of tinea, or rolled somewhat inward; they are sometimes found entirely obliterated either by disease or injury, burns of the eyelids being the most common cause.

The canaliculi may also be found more or less obstructed in any part of their course, at times by a little mass of fungus. Any of these conditions are accompanied by trou-

blesome watering of the eye—"epiphora." They can be remedied by slitting the tear puncta and canaliculi.

The lachrymal sac is often the seat of acute inflammation, which may arise in the sac itself, spread to it from the conjunctiva, or be caused by disease of the surrounding bones. It is characterized by a dusky-red tense swelling situated at the side of the nose, close to the inner canthus, the swelling and redness often extending outward along both the upper and lower lids; one or both sacs may be affected. The inflammation may end in resolution or go on to the formation of an abscess; in the latter case the swelling becomes soft and fluctuating.

Treatment.—At first hot fomentations and poultices must be applied and attention paid to the general health; if abscess form, the pus must be let out by a free incision. If an abscess of the lachrymal sac be allowed to burst, a fistulous opening will very probably be left; but if a free opening be made so soon as the formation of pus is suspected, the wound heals readily.

Distension of the Lachrymal Sac (Mucocele).—The lachrymal sac not unfrequently becomes distended, forming a tumor of varying size beneath the internal palpebral ligament (tendo oculi); pressure on the tumor causes the escape of a transparent, somewhat tenacious fluid consisting of mucus and tears, in some cases thickened from the admixture of pus cells. Distension of the sac is caused by stricture of the nasal duct and consequent accumulation of secretion; it is accompanied by more or less watering of the eye and may be remedied by relieving the stricture of the duct.

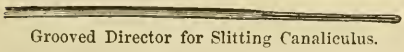
Discharge from the Lachrymal Sac (Blennorrhœa).—A muco-purulent or purulent discharge from the sac is often met with following inflammation, especially if disease of the adjacent bone exist. It may be treated—1st. By ensuring a free exit for the discharge by slitting the canaliculus and passing a large probe down the lachrymal duct; 2d. By washing out the sac; 3d. By obliteration of the sac.

Stricture of the nasal duct may be met with in any part of its course; the obstruction, however, is most frequently found at its junction with the lachrymal sac. Occasionally the duct is found almost obliterated by dense bony deposit.

Fistula of the lachrymal sac occurs as a small, sometimes scarcely perceptible opening situated at some point over the sac; it is found in connection with obstruction of the nasal duct. If the passage be re-established, the fistula will probably close.

Operations on the Tear Passages.—The operation of slitting the tear puncta and canaliculi may be performed thus: The patient should be seated in a chair, the operator standing behind him (see Fig. 110, p. 290). Supposing the lower punctum and canaliculus on the right side to be operated on, the small and ring fingers of the left hand should be placed upon the patient's face near the outer canthus, the lids drawn tight with these two fingers, and kept so; then a small grooved director (Fig. 115) should be taken in the right hand and passed at first vertically to the margin of the lid through the tear punctum, its handle then depressed, and its point passed horizontally along the canaliculus into the sac. To ascertain that the point of the director is in the sac, the tension of the lids must be relaxed and the director pushed gently onward. If there be any puckering at the inner canthus when the director is thus pushed, its point has not entered the sac, and a further attempt must be made; if no puckering occur, the lids should be brought again into a state of tension and the handle of the director transferred to the thumb and forefinger of the left hand. A cataract or any small knife that will cut should then be taken in the right hand and run along the groove of the director well into the sac, the knife and director being then withdrawn together; the upper lid must be kept out of the way by one of the fingers of the right hand. The operation can be performed on the left side in the same manner, with the exception that the hands are reversed.

Fig. 115.



Grooved Director for Slitting Canaliculus.

The upper punctum and canaliculus sometimes require to be slit; this operation is not quite so simple as that on the lower lid, but is performed in much the same way. In lieu of the grooved director and knife, a small probe-pointed canaliculus knife may be employed; it should be passed through the tear punctum and canaliculus in the same manner as the director, and will cut its way out as it goes.

The patient must be seen at intervals of two or three days for a week or longer after the operation, and a probe passed along the incision to prevent its closing.

Probing the Nasal Duct.—For the treatment of stricture of the nasal duct a set of silver probes (Bowman's) are used; there are three probes in a set, the two extrem-

ities of each being of different thicknesses, so that there are six sizes, No. 1 being the smallest, No. 6 the largest.

To pass a probe down the nasal duct, the canaliculus should be first slit, or, what is better, should have been slit at some previous time. The surgeon should stand behind the patient in the same position as for performing the last operation, and, the lids being made tense in the same manner, the probe should be passed along the slit canaliculus until the point is well within the sac, as shown by the absence of puckering at the inner canthus on relaxation of the tension of the lids; the opposite extremity should then be raised along the margin of the orbit until the probe has attained a vertical direction, care being taken, while so doing, to keep the end which is in the sac pressed firmly against its inner side; the probe, having been brought into a nearly vertical position, should be pushed gently but firmly downward and slightly backward and outward in the direction of the duct; when it has been passed as far as it will go, it should be slightly withdrawn, so as to raise its end off the floor of the nose. If the probe has been properly passed down the duct, its upper part will remain firmly in contact with the margin of the orbit; but if it moves freely about, the probe is not in the duct, but has been forced through its wall. This little accident is of no particular moment, and needs only that the probe be withdrawn and passed afresh in the right direction.

If the end of the probe is not well within the sac before an attempt is made to pass it down the duct, it may slip backward into the orbit or forward and downward in the cellular tissue of the cheek. A probe, having been satisfactorily passed, should be left in for about twenty minutes, and the operation be repeated about twice a week. The treatment of stricture of the lachrymal duct is, on the whole, unsatisfactory, but the probing should be carefully and perseveringly carried out. It is well always to commence with the largest probe (No. 6), and try a smaller one if this cannot be passed.

Washing out the Lachrymal Sac.—For washing out the lachrymal sac a good syringe fitted with nozzles of different sizes is required. One of the nozzles should be fitted to the syringe, which has been previously filled with fluid (water, a weak solution of nitrate of silver, chloride of zinc, etc.); the nozzle should then be passed along the previously slit canaliculus into the sac and the fluid injected; the patient's head must be bent forward during the injection, or the fluid will run back along the floor of the nose into the pharynx.

Obliteration of the Lachrymal Sac.—In some cases of obstinate discharge from the sac, especially if dependent on diseased bone, the discharge may be stopped and the patient made more comfortable by closing up the sac entirely; of course, more or less watering of the eye will remain after the operation, but is far to be preferred to the annoyance of a constant purulent discharge.

Obliteration of the sac may be attempted in any of the three following ways: A free incision having been made into it and the blood carefully sponged out, its lining membrane may be destroyed—(1) by filling its cavity with a thick paste of chloride of zinc and starch, in equal parts, enclosed in a small piece of lint, (2) by the application of nitrate of silver, or (3) by the galvanic or other cautery. By any of these procedures adhesive inflammation is set up, more or less obliteration of the sac following.

Operations for obliteration of the lachrymal sac are by no means always successful and may have to be repeated, perhaps more than once, before a satisfactory result is obtained.

THE CONJUNCTIVA.

But few operations are performed on the conjunctiva alone; it is, of course, cut in some of the operations on the eyelids and in that for strabismus, and some others.

Warts are occasionally found on some part of the membrane; they require to be removed with scissors.

Pterygium is a peculiar, somewhat triangular growth, the base of which is situated in the ocular conjunctiva, generally near the inner canthus, the apex encroaching more or less upon the margin of the cornea or passing for a considerable distance upon its surface. The growth is of a reddish color and variable density; it consists of hypertrophied connective tissue.

Pterygium is not common in this country, and when met with is usually found to occur in sailors and others who have been in the East. Should it give rise to any inconvenience or threaten to impair vision, it must be removed by operation.

The patient should lie on the couch, the lids be opened by a wire speculum, the growth seized with toothed forceps, and with a cataract knife dissected up from the sur-

face of the cornea. A small portion of conjunctiva should then be removed parallel with the margin of the cornea and the apex of the growth fixed by a suture in the wound. The eye should be kept bound up for a few days with wet lint and a bandage.

If a pterygium is simply cut off, it will in all probability grow again; but if transplanted, it will shrivel up and disappear without giving further trouble. A cicatrix always remains upon the cornea after removal of pterygium, so that it must never be allowed to grow over the pupil.

Pinguiculæ are small yellowish growths situated beneath the conjunctiva, generally near the outer and inner margins of the cornea; they are surrounded by a few large blood vessels and are occasionally the source of constant irritation, causing the eyes to be bloodshot and uncomfortable. Pinguicula can be removed, if desired, by making an incision over it, turning back the conjunctiva, then seizing the little growth with forceps and dissecting it away from the parts beneath. The growth having been removed, the conjunctiva should be closed over the wound by a suture and the eye kept bandaged for two or three days after the operation.

Lipoma is met with as a tumor projecting beneath the upper lid, near the fornix, and often between the superior and external recti muscles; it somewhat resembles a third lid. If the tumor gives any trouble, it must be removed by operation, thus: The patient lying on the couch, the lids should be kept as widely open as possible by a wire speculum, an incision made with a cataract knife through the conjunctiva over the tumor, and its most projecting portion seized with toothed forceps and removed with scissors; care must be taken not to drag upon the growth, as it is continuous with the fat in the cavity of the orbit, a great portion of which might be pulled out. As much of the tumor as is thought necessary having been removed, the conjunctiva should be closed over it with sutures and the eye bound up.

Nævus occasionally occurs in the conjunctiva; it may be removed by the knife or destroyed by the galvanic or other cautery. In the latter case due precautions must be taken to guard the eyeball from injury during the operation, and to prevent as much as possible the evils arising from subsequent cicatrization.

Cancerous ulcers may also be met with; they must be thoroughly extirpated, the eyeball being excised if necessary.

Cysts containing a clear serous fluid are occasionally met with in the conjunctiva; they must be punctured, when they at once subside, but sometimes re-form, in which case a portion of the cyst wall must be excised or a fine seton passed through it.

Cysticercus also occurs, and should be treated by incision of the cyst.

EXTERNAL MUSCLES OF THE EYEBALL.

Strabismus (squint).—"Strabismus is a deviation in direction of the axes of the two eyeballs, in consequence of which the two yellow spots receive images from different objects. In convergent strabismus the two visual lines do not cross each other at the point it is desired to observe; only one of the two—that of the undeviating eye—reaches it. Under this deviation not only does the expression of the face suffer from want of symmetry in its most eloquent parts, but the power of vision—at least, in one of the eyes—is usually disturbed, and the squinter always loses the advantage of binocular vision" (Donders).

Strabismus must not be looked upon as a special form of disease; it is in by far the greater number of cases associated with some anomaly of refraction, which, being the primary cause of the deviation, gives rise to the strabismus. Other conditions which may induce strabismus will be subsequently considered.

Two forms of squint are commonly met with: 1. Convergent; 2. Divergent. Other rare forms are superior and inferior strabismus; these will receive no further notice.

Convergent strabismus is the most common of all, and is almost always the result of hypermetropia.

Divergent strabismus is usually the result of myopia.

Convergent strabismus, as just stated, is nearly always the result of hypermetropia. The question naturally arises, How does hypermetropia produce it?

The hypermetropic individual must always accommodate strongly when looking at even a distant object, and as the object is brought nearer the tension of accommodation must be correspondingly increased. As stated at page 264, accommodation is associated with convergence of the visual lines. Now, the greater the degree of convergence, the more strongly is the accommodation brought into play; consequently, there is an ever-

increasing tendency on the part of the hypermetropic individual to converge too much, in order to bring his accommodation into the highest possible state of tension. If the convergence of the visual lines be excessive or they do not meet in the same point, convergent strabismus results.

The question next arises, Why do not all hypermetropic individuals squint? The reason is that if both eyes are of the same refraction and have equal acuteness of sight there is always such a desire to maintain binocular vision that the visual lines will remain directed to the same point, even though the eyes are not accurately accommodated for that point, the individual being content with ill-defined retinal images rather than sacrifice binocular vision by increasing his convergence.

But if vision of one eye be less acute than that of the other or if there be a difference of refraction between the two, the desire for binocular vision is lost or its value very much lessened, and the necessity for a well-defined image on one retina is immediately felt. The accommodation is put fully on the stretch, and with it the degree of convergence becomes excessive, both visual lines being directed to points nearer to the eyes than that for which they are accommodated, the deviation of the more defective eye being greater than that of its fellow.

Ordinary convergent or "concomitant" squint has to be distinguished from squint the result of paralysis—"paralytic" squint. This can be done by noticing the relation of the convergence of the eye which is observed to be squinting—"primary" squint—to the deviation—"secondary squint"—which occurs in the properly directed eye when it is covered and an attempt made to fix an object with the squinting eye. In concomitant squint the "primary" and "secondary" deviations are equal; in paralytic squint the "secondary" deviation is greater than the "primary."

Treatment.—Slight cases of convergent strabismus, especially if the deviation is not constantly present, but only occasional (periodic squint), may be cured by the use of glasses which accurately neutralize the existing hypermetropia.

In more severe cases division of the internal rectus tendon in one or both eyes is necessary.

It is often difficult to decide whether only one or both eyes shall be operated on.

If it is found that one eye squints habitually and to no great extent, the other being always used for fixing an object, division of the internal rectus of that eye which habitually deviates alone is necessary.

If each eye deviates alternately (alternating strabismus) and to no great extent, division of one internal rectus may be sufficient; but if, three weeks or a month after the operation, the squint still continues, tenotomy of the internal rectus of the other eye should be performed.

If one eye squints considerably and habitually or if the deviation is excessive and alternating, the internal rectus in both eyes must be divided. In any case, if there be a doubt as to whether one or both eyes should be operated on, it is well to be on the safe side and do only one at a time.

Operations for Convergent Strabismus.—There are two principal methods of operating for convergent strabismus.

1. The operator should stand on the right side of the patient, placed in the usual position (Fig. 111, p. 290), and, the eyelids being kept well open with a wire speculum, should seize the conjunctiva and subconjunctival fascia with the toothed forceps (Fig. 116, *a*) at a point about midway between the margin of the cornea and semilunar fold and just below the inferior margin of the tendon of the internal rectus muscle. An incision should then be made with strabismus scissors (Fig. 116, *c*) through the conjunctiva and subconjunctival fascia, well down to the sclerotic, and the strabismus hook (Fig. 116, *b*) passed through the opening and inserted between the tendon and the eyeball. If properly introduced, the hook will be brought up short at the insertion of the tendon into the sclerotic when it is pulled forward; it should be held firmly in position, the scissors passed through the opening, one blade following the hook between the tendon and the eyeball, the other being kept outside the tendon, which is thus included between the two blades, and the tendon should then be divided by one or two sharp strokes with the scissors.

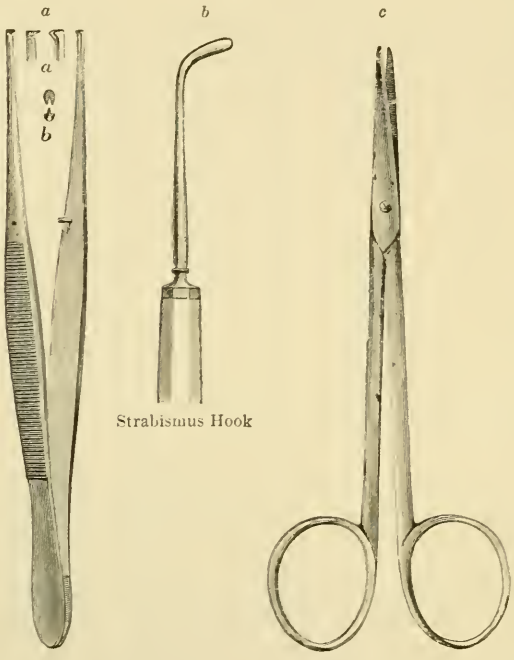
The scissors may now be withdrawn and the hook pulled forward; if the latter meets with no resistance, but passes freely up to the corneal margin, the operation has been successfully performed. To make sure of this, however, the hook should be withdrawn, the action for hooking the tendon repeated, and any fibres that may have escaped division cut through.

On the division of the tendon the muscle retracts, the retraction being limited by the subconjunctival fascia with which it is intimately connected. If the eye is not properly directed after simple division of the tendon, a greater effect may be produced by further freely severing the subconjunctival fascia.

2. In the second operation the position of the patient and surgeon should be the same and the lids be kept open with the wire speculum, as in the one already described.

An incision should be made with scissors through conjunctiva and subconjunctival fascia over the insertion of the tendon, instead of below its inferior margin, the tendon then picked up with the strabismus hook, and divided close to the sclerotic. The wound in the conjunctiva should be afterward closed with a fine suture.

FIG. 116.



Toothed and Fixing Forceps. *a*, their points shown in side view; *b*, front view.

Strabismus Scissors.

No after-treatment is required for strabismus operations; the patient may go about as usual and simply keep the eyes clean. But if, when the eyes have quite recovered from the effects of the operation, there should be any return of the squint, the degree of hypermetropia must be carefully ascertained and glasses which thoroughly neutralize it ordered to be used for all purposes. In most cases this will be found sufficient; but if, after the glasses have been perseveringly worn for some weeks, no effect is produced, the operation should be repeated in one or both eyes.

Use of Anæsthetics in Operations for Convergent Strabismus.—Whether anæsthetics should be employed or not in squint operations appears to be a matter of opinion, some eminent oculists never employing them, others again rarely operating without. For my own part, I prefer not to employ an anæsthetic if the patient is pretty steady, but with children and nervous adults I always use one, taking care, however, that a full effect is not produced; and if there is any doubt as to whether one or both eyes are to be operated on, I allow the patient to come nearly to after finishing one eye, so as to ascertain the effect produced by what has been done. If an anæsthetic is given to such an extent as to exert its fullest influence and produce thorough muscular relaxation, an erroneous idea of the effect of the operation is likely to be formed, and on the return of consciousness the squint may remain as bad as ever.

Other conditions than hypermetropia which may produce convergent strabismus are—

1. Disease of the brain.
2. Paralysis of the external rectus muscle.
3. Inflammatory or other changes in the internal rectus muscle itself, producing shortening.

In the first two of these no operation is advisable; the third may sometimes be remedied by operative interference.

Divergent strabismus, as already stated, is often the result of myopia; it is usually consequent on high degrees of the anomaly and is brought about as follows: The highly myopic individual requires to bring objects very near the eyes to see them distinctly; consequently, a very high degree of convergence is necessary to keep both visual lines directed to the same point. Now, not only has a high degree of convergence to be maintained, but in myopia the length of the eyeball and the consequent impairment of its mobility place the internal recti at a disadvantage. Moreover, in order to direct

the visual lines of the myopic eyes to the same point, a greater proportionate amount of convergence is required than in emmetropia.

As a consequence, the internal rectus of one eye sooner or later becomes wearied and gives in and the eye deviates outward, binocular vision being sacrificed.

Treatment.—Many cases of divergent strabismus may be remedied by the use of concave glasses, which enable the individual to see distinctly at a distance up to which convergence of the visual lines can be maintained without undue strain of the internal recti muscles.

If, in spite of the use of glasses, the divergence continues, it must be remedied by operation. In cases where the eye only deviates outward after an object has been looked at for some considerable time, subconjunctival division of the external rectus of the deviating or of both eyes may suffice for a cure; but in cases where one or both eyes diverge constantly, and the visual lines can only be made to meet in one point by a great effort, or not at all, the operation of "readjustment" must be performed.

This operation can be performed as follows: The patient being placed in the usual position (Fig. 111, p. 290) and thoroughly anæsthetized, the operator should stand behind, fix the lids open with a wire speculum, with scissors make an incision through the conjunctiva and subconjunctival fascia below the insertion of the external rectus, hook up the tendon, and divide it subconjunctivally close to the sclerotic.

An incision should then be made through conjunctiva and subconjunctival fascia, about midway between the insertion of the internal rectus and inner margin of the cornea, of such a length as to reach about two lines above and a like distance below the margins of its tendon, which should then be hooked up and divided. The muscle and subconjunctival fascia should be freely separated from the parts beneath and together with the conjunctiva turned back toward the caruncle. Two curved needles holding fine silk should then be passed through the tissues next the margin of the cornea and the silks firmly tied, two free ends being left; the needles should then be carried from within outward through the muscle, subconjunctival fascia, and conjunctiva, as near the inner canthus as possible, and the silk drawn through; a considerable portion of the muscle and other tissues should then be removed with scissors, the free ends of the two fine pieces of silk and the portions to which the needles are still attached then tied firmly together (the eye being rolled well inward by an assistant as the knots are pulled tight), and the ends of the two sutures cut off close.

The eye should be bound up with wet lint and a bandage. The sutures will probably require removal in about four or five days, but may be left longer if they cause no irritation.

Divergent strabismus is met with in cases of paralysis of the third nerve; it may also occur in non-hypermetropic eyes if the sight of one has become much impaired and binocular vision is no longer possible, and may be caused by too free a division of the tendon in the operation for convergent squint. In the first of these cases no operation is advisable; in the second, no improvement of sight is to be expected from readjustment, but the operation may be performed simply to remedy disfigurement; in the third, readjustment should be performed.

THE CORNEA.

The affections of the cornea which require an operation upon the structure itself are six: 1. Sloughing ulcer; 2. Conical cornea; 3. Corneal opacity; 4. Staphyloma; 5. Lodgment of foreign bodies; 6. New growths.

Paracentesis, or Tapping the Cornea.—This operation is sometimes performed in cases of sloughing ulcer, or suppuration, threatening perforation; by the timely evacuation of the contents of the aqueous chamber a large rupture of the corneal tissue, with its accompanying evils, may in many cases be avoided.

Tapping the cornea may be done thus: The patient being in the usual position (Fig. 111, p. 290), the operator should stand behind and fix the lids open by a wire speculum or by the fingers. A broad needle should then be passed through the cornea at some convenient part of its margin; when the point of the needle has fairly entered the anterior chamber, its handle should be rotated, so as to bring the breadth of the blade across the incision and thus open it; as soon as the contents of the anterior chamber have flowed out the needle should be withdrawn, a drop of eserine solution placed between the lids, and the eye bound up in the usual manner.

Iridectomy, however, is to be preferred to paracentesis.

Conical cornea ("Staphyloma corniæ pellucidum"), as the name implies, signifies an alteration in the curvature of the cornea of such a nature that it assumes the form of a cone. The origin of the affection cannot clearly be traced.

The most prominent symptom is gradually increasing myopia, which cannot be remedied by concave lenses. On looking at the cornea in profile its conical form is very evident.

On examination with the ophthalmoscope by the direct method, the apex of the cone, which may, however, be the seat of some opacity, appears brightly illuminated; around this bright portion is a dark ring corresponding to the sides of the cone, this being again succeeded by an area giving a bright reflection and corresponding to a portion of the cornea which retains more or less its natural curvature.

Objects occupying the fundus of the eye are seen through the apex and sides of the cone near its base in an inverted position, as in myopia, whilst we obtain a more or less distinct erect image of the same parts through the portion of cornea which still retains its normal curvature. The retinal vessels appear to have a whirl-like motion as we change our point of view from side to side. The appearance is quite characteristic, and, once seen, is not likely to be forgotten.

Treatment.—Conical cornea can only be remedied by operative interference; two methods of operating are practised, the object of each being to flatten the cone and restore to the cornea more or less of its natural curvature.

In one operation an elliptical portion including the whole thickness of the cornea is removed from the apex of the cone. The operation can be performed thus (for the position of patient and operator see Fig. 111, p. 290): An anæsthetic should be given, the lids held open by a wire speculum, and the eyeball fixed by seizing with the toothed forceps the conjunctiva and subconjunctival fascia at some point near the corneal margin. A straight cataract extraction knife (Fig. 120, *c*) should then be thrust through the cone from side to side, a small flap formed by cutting out either upward or downward, and the flap so made seized with iris forceps and removed with scissors.

In this operation the anterior chamber is opened and the cornea collapses as soon as the first incision is made. Care must be taken that the portion removed includes the most prominent part of the cone, and that the opening left is exactly opposite the pupil.

After the operation the speculum must be very carefully removed, and the lids gently closed and bandaged in the usual way; the eye must on no account be examined for a week, so as to give time for the opening in the cornea to fill up. The wound will in all probability heal in the course of ten days, the anterior chamber being restored.

The margin of the pupil is not unfrequently caught up in the incision, an anterior synechia resulting.

The operation described gives the most satisfactory results, the curvature of the cornea being greatly improved and a corresponding amount of vision regained.

In the second operation a superficial portion only is removed from the apex of the cone with a small trephine, a raw surface being left, which by its subsequent cicatrization and contraction causes considerable flattening of the cone.

Tinting the cornea is called for in cases of dense white opacity (leucoma), causing disfigurement. The operation can be performed as follows (for position of patient and operator see Fig. 111, p. 290): An anæsthetic having been given, the operator should place the wire speculum between the lids, fix the globe with the toothed forceps, paint some Indian ink upon the opacity, and prick it thoroughly in with a bunch of needles fixed in an ivory handle; the ink should be sponged away from time to time in order to allow the operator to see what progress he has made.

The opacity having been thoroughly tinted, the speculum should be removed; no bandage need be applied, and no after-treatment is necessary; very little irritation follows. If, after the lapse of a week or ten days, the opacity do not appear sufficiently blackened, the operation may be repeated.

If the ink be allowed to get into the wound made in the conjunctiva by the toothed forceps, a black mark will be left; care should therefore be taken to fix the globe at a point to which the ink cannot run. Should the anterior chamber be opened, the operation must be discontinued, as the lens may be wounded.

Staphyloma, first so called from its supposed resemblance to a grape, has now come to mean a bulge on any part of the eyeball. On the cornea it is caused either by yielding of its structure or more commonly by prolapse of iris through a perforation in it, the prolapsed portion being firmly coated over with inflammatory material. Staphyloma is said to be "total" where the whole of the cornea is affected, "partial" when

some portion of it retains its normal curvature. Total staphyloma should be removed by abscission (see p. 275), or the eyeball may be excised. Partial staphyloma may subside on the performance of iridectomy or can be removed as follows: The position of patient and operator should be as at Fig. 111, p. 290, and an anæsthetic should be administered. The lids being kept open by the wire speculum, a curved needle armed with fine silk should be passed through the base of the staphyloma, an elliptical portion of which should then be removed with a straight cataract knife; the silk should then be drawn through and tied, thus bringing the edges of the gap made by the removal of the elliptical portion together, and the eye bandaged in the usual way. The suture may be removed in the course of three or four days.

Foreign Bodies.—Small fragments of metal, chips of stone, thorns, etc., are not unfrequently found lodged in the cornea. To remove them the position of patient and operator should be as at Fig. 110, p. 290. As a rule, no anæsthetic need be administered. The lids should be kept open by the fore and ring fingers of one hand, and the globe steadied by gently pressing upon it with the second finger; the foreign body should then be carefully lifted from its bed with the point of a knife or small spud held lightly in the other hand. Foreign bodies, especially thorns, are sometimes so firmly and deeply embedded that they require to be cut out.

New growths may be met with springing from the cornea.

Congenital tumor is a small white flattened elevation usually situated near the corneal margin, encroaching on both cornea and sclerotic; it lies beneath the corneal epithelium and conjunctiva and appears to extend pretty deeply into both cornea and sclerotic; the growth is present at birth, but usually increases somewhat as the child grows up. It may give rise to astigmatism by causing distortion of the cornea.

The growth may be single or there may be two or three little tumors. Their structure is that of connective tissue, and occasionally small hairs grow upon them.

Should the little growths give rise to inconvenience, they can be shaved off level with the cornea, but, as a rule, they cannot be entirely removed.

Round and spindle-celled sarcomata have also been met with growing from the cornea. Such cases usually call for extirpation of the eyeball.

THE SCLEROTIC.

Sclerotomy, as already stated, is one of the operations for the treatment of glaucoma. In performing the operation, the position of operator and patient should be as in Fig. 111, p. 290. The instruments required are a straight cataract knife (Fig. 120, *c*), speculum, and fixing forceps. The lids should be held open with the speculum, the eyeball fixed with the forceps. The knife should be entered on the outer side of the globe as far back in the sclerotic as is consistent with the entering the anterior chamber quite at its periphery, pushed across the chamber, and brought out at a corresponding point on the inner side. The transfixion having been finished, the incisions should be enlarged to about double the width of the knife blade, which should then be withdrawn, its point being carried round the margin of the anterior chamber so as to notch the parts bounding it, but not cut through the sclerotic. The division of the sclerotic may be made either upward or downward, the points of puncture and counter-puncture be situated midway between the horizontal meridian of the cornea and its upper margin in the former case, midway between its horizontal meridian and lower margin in the latter.

THE IRIS.

Iridectomy is called for in all cases in which it is desirable to influence the tension or nutrition of the eyeball; it is associated with some operations for cataract, in a somewhat modified form is one of the methods of making an artificial pupil, and is useful in some other conditions.

The operation is performed—

1. To influence tension.

(*a*) *In sloughing ulcers*, or suppuration of the cornea, accompanied by pain and threatening perforation. In such cases iridectomy gives almost instant relief to the most severe pain, and in all probability will save the cornea from rupture.

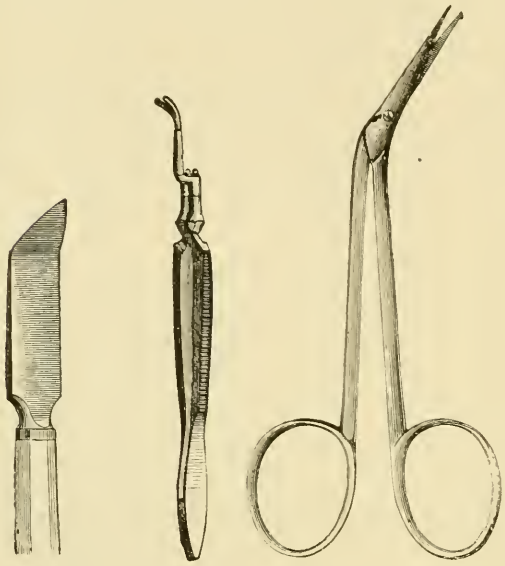
(*b*) *In injuries of the eyeball* in which the crystalline lens, being wounded, has become opaque and swollen and is pressing on surrounding parts, causing severe pain and threatening the integrity of some of the delicate structures within the globe. In these cases

not only does iridectomy diminish tension, and so relieve pain, but gives room for any subsequent swelling of the lens.

(*c*) *In staphyloma of the cornea* iridectomy often causes complete subsidence of the projection.

(*d*) *In glaucoma* a timely and well-performed iridectomy causes instant and lasting diminution of tension and places the eye in comparative safety; the operation should be performed on any eye that can distinguish *bright* light, and to relieve pain in any case, whether there be perception of light or not; in acute glaucoma it must be tried even if all perception have been lost for some days.

Fig. 117.



a. Bent Iridectomy Knife. *b*. Iris Forceps. *c*. Iris Scissors.

2. To influence nutrition, iridectomy should be performed in chronic choroido-iritis, recurrent iritis, and in cases of total exclusion of the pupil where there is no communication between the anterior and posterior divisions of the aqueous chamber.

3. Associated with operations for cataract, iridectomy should be performed previous to a needle operation if much swelling of the lens be anticipated, or it may require to be done after the needle has been used if pain or increase of tension occur.

The operation should also be performed at some time previous to or simultaneously with small flap or linear extraction of cataract.

4. Iridectomy for artificial pupil is mentioned at another page.

5. Other conditions in which iridectomy may be required are—

(*a*) Hemorrhage into the vitreous humor.

(*b*) Displacement of the retina.

(*c*) As an aid to the removal of foreign bodies from the globe.

(*d*) Some peculiar conditions of intraocular circulation.

Operation of Iridectomy. *Instruments.*—A wire speculum (Fig. 114), a straight or bent iridectomy knife (Fig. 117, *a*), a pair of toothed forceps (Fig. 116, *a*), a pair of iris forceps (Fig. 117, *b*), iris scissors (Fig. 117, *c*), and a curette (Fig. 120, *a*). For the position of patient and surgeon see Fig. 111, p. 290. The patient should be brought fully under the influence of an anæsthetic, the lids kept widely open by the wire speculum, and the eyeball fixed by seizing the conjunctiva and subconjunctival fascia near the corneal margin with the toothed forceps; then, with a straight or bent iridectomy knife of medium size, an incision should be made in the sclerotic in such a position that the knife enters the anterior chamber quite at its peripheral part and close to the anterior surface of the iris.

The knife, having entered the anterior chamber, should be pushed steadily on (care being taken to keep its point well forward toward the cornea, so as not to wound the lens) until the point is opposite the centre of the pupil. The point should then be turned to one side, so as to be out of the pupillary area, and the knife slowly and gently withdrawn, the hold of the forceps being let go at the same time. The incision thus made should be of such a length as to correspond to a little more than one-fourth of the circumference of the iris.

The next step in the operation is the removal of a portion of the iris. If, as is not unfrequently the case, the iris has become prolapsed, it needs only to be seized with the forceps and a piece of the desired size removed with the scissors. If the iris does not protrude, the iris forceps should be introduced, shut, through the wound in the sclerotic, and pushed on until the extremities of their branches are opposite the nearest portion of the pupillary margin; they should then be allowed to open of themselves, when the iris

will be pushed between the branches by the pressure of the parts behind; no backward pressure must be made with the forceps, but they should be gently closed again and withdrawn, carrying the iris with them, which should then be cut across with the scissors, close to one angle of the wound, drawn over to the other angle, and a piece cut off; the curette should be passed between the lips of the wound, so as to push back any portions of iris that may have become entangled in it. The eye should then be bound up with lint and a bandage. The form of the pupil after a well-performed iridectomy should resemble Fig. 119, D.

With regard to the position of the portion of the iris to be removed opinions are at variance. If the surgeon be a skilful and experienced operator and has the aid of a competent assistant, the iridectomy should be done upward, so as to place the gap beneath the upper lid, and thus conceal it as much as possible.

To perform iridectomy upward, a bent iridectomy knife should be used and the incision made in the sclerotic above the upper margin of the cornea; an assistant should then draw the eyeball downward with forceps, the iris forceps should be inserted, and the portion of iris removed as previously directed.

An inexperienced operator will find it much easier to remove the portion of iris from its outer and lower segment. In this case a straight iridectomy knife can be used and no assistant is required. The result is rather an ugly gap, the disadvantage of which, however, is quite counterbalanced by the ease and safety with which the operation can be performed.

Accidents which may happen during the Operation of Iridectomy and Difficulties which may be encountered.—The accidents which may occur are—

(1) Wound of the lens from insufficient care in keeping the point of the knife well forward and out of the area of the pupil. This accident will in all probability be followed by the formation of traumatic cataract.

(2) Escape of vitreous humor is very likely to occur in hard eyes if the knife be too quickly withdrawn or if undue pressure be exerted on the globe with the fixing forceps.

(3) The iris may be torn away from its insertion at a point opposite to the incision if undue traction be exercised upon it with the iris forceps.

Difficulties.—The iris may be found so rigid that it cannot be seized with the forceps, or so rotten that only very small portions can be brought away; sometimes it bleeds profusely when touched, filling the anterior chamber with blood and considerably hindering the operation.

Artificial Pupil.—The operation for artificial pupil is performed to open a new path for rays of light to the retina, the natural passage being obstructed.

It is indicated in the following cases: (1) In opacity of the cornea, with or without anterior synechiæ; (2) In closure of the pupil; (3) In extensive posterior synechiæ; (4) In central opacity of the lens or its capsule.

The artificial pupil must be small, as nearly central and as well defined as possible. Care must be taken to make it behind that portion of the cornea which is most transparent and least altered in curvature, the best situation being ascertained by oblique illumination. The new pupil must not be made upward, or it will be covered by the upper lid.

An artificial pupil can be made in any of the following ways: (1) By incision of the iris; (2) By tearing it away from its insertion; (3) By excision of a portion (iridectomy for artificial pupil); (4) By ligature.

In operations for artificial pupil the position of patient and surgeon should be the same as in "iridectomy," and an anæsthetic should be administered.

1. (*a*) **Incision** (Fig. 119 A).—This operation is called for in cases of complete closure of the pupil following removal of the lens either by operation or injury, but is not advisable unless the lens be absent. In these cases the iris may be found changed into a tense, unyielding membrane which cannot be seized with forceps.

The operation of "incision" may be performed either by thrusting a broad needle through the cornea near its margin and then incising the iris, so as to cut across its radial fibres, or, an incision having been made with an iridectomy knife in the sclero-corneal margin, a pair of scissors (having one sharp and one blunt-pointed blade) may be introduced through the wound, one blade being thrust through the iris at its nearest point and passed behind it, the other carried along its anterior surface, and the iris then cut fairly across from one side to the other.

Whichever plan of incision is adopted, the vitreous humor pushes forward into

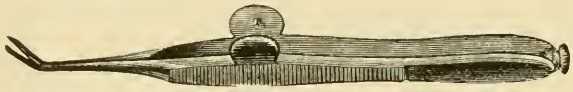
the wound and keeps its edges widely separated, a pupil resembling Fig. 119 A, being formed.

Two other methods of making an artificial pupil by "incision" have been lately introduced; they are known as single and double "iridotomy."

For the positions of patient and surgeon in performing either of these operations see Fig. 111, p. 290.

(*b*) *Single iridotomy* should be thus performed: The eyelids being kept open with the wire speculum and the eyeball fixed by seizing the conjunctiva and subconjunctival fascia close to the margin of the cornea at its inner side, an incision should be made with an iridectomy knife in the cornea about midway between its margin and the pupil and opposite to the point of fixation with the forceps. The forceps scissors (Wecker's, Fig. 118) must be then introduced, closed, through the wound into the anterior chamber, the blades opened, one passed through the pupil behind the iris, the other on its anterior surface, and the sphincter of the pupil be divided with one sharp cut. The scissors should then be withdrawn, any prolapse of iris that follows replaced with the curette, a drop of atropine placed between the lids, and the eye lightly bandaged.

FIG. 118.

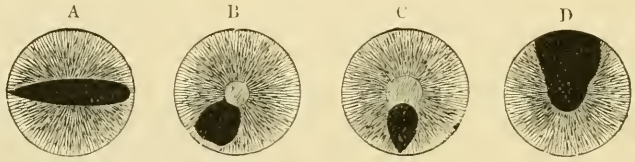


Wecker's Scissors.

This operation is applicable to cases where the lens is present, its centre being opaque and its peripheral portion clear.

(*c*) *Double iridotomy* is applicable to cases of closed pupil after cataract extraction. An incision should be made through the upper part of the cornea, the knife carried through the iris and along its posterior surface, so as to make a fair-sized wound in it; the incision being finished, the knife should be carefully withdrawn, and very possibly some vitreous humor will follow it.

FIG. 119.



A. Pupil after Incision. B. Pupil after Excision. C. Pupil after Ligature. D. Iridectomy for Glaucoma, etc.

The next step in the operation is to pass the forceps scissors, closed, through the wound in the cornea into the interior chamber, open them, pass one blade behind the iris, the other in front of it, make an incision in a direction downward and inward; then change the direction of the scissor blades and make a cut downward and outward. Thus a small piece of iris is enclosed by a V-shaped incision, the apex of the V being upward. The small portion of iris contracts up and a somewhat triangular pupil is left. The eye should be bound up as usual.

2. **Tearing away the Iris from its Insertion (Iridodialysis).**—An incision having been made through the cornea on the side opposite to that on which the iris is to be removed, a pair of iris forceps should be passed through the wound and across the anterior chamber, the iris seized close to its greater circumference and torn forcibly away from its insertion; the instrument should then be carefully withdrawn and the eye bound up. If necessary, the whole iris may be removed in this way. This operation is applicable to cases of dense corneal opacity (leucoma) occupying the whole of its central part, some transparent cornea being left at the margin.

3. **Excision; Iridectomy for Artificial Pupil.**—An incision should be made of the requisite size through some part of the sclero-corneal margin, the iris forceps introduced through the wound, the ends of their branches passed fairly up to the margin of the pupil, the iris seized and drawn out through the wound, and a small portion removed with scissors. The curette should then be passed between the lips of the wound, so as to push back any portion of iris that may have become entangled in it; a pupil resembling Fig. 119, B, should be formed.

4. **By Ligature (Iridodesis, or Iridesis).**—An incision should be made with a broad needle near the margin of the cornea, a small noose of silk laid upon the surface of the eyeball so as to encircle the incision, an iris hook or canular forceps then passed through the noose and wound, and the iris drawn gently out; an assistant with two pairs

of broad-ended forceps should seize each end of the noose and firmly ligature the included portion of iris; the ligature will drop off in the course of a few days, a pupil resembling in shape Fig. 119, C, being left.

THE CRYSTALLINE LENS.

Cataract.

By cataract we understand an opacity of the crystalline lens.

The causes of this opacity are somewhat obscure, but it probably depends on impairment of nutrition of the lens consequent on senile decay or constitutional conditions (*e. g.*, diabetes).

It also occurs in connection with inflammatory changes in adjacent parts—the choroid, ciliary body, vitreous, and iris—is met with as a congenital defect, and very frequently results from injury.

Forms of Cataract.

There are two principal forms of cataract:

1. *The cortical or soft cataract.*
2. *The nuclear or hard cataract.*

In the first form the cortical substance of the lens is primarily affected, the nucleus afterward becoming opaque, the whole being soft, or even fluid.

In the second the nucleus of the lens first becomes hard, yellowish, and opaque, the cortical substance being subsequently affected.

The cortical cataract is met with as an idiopathic disease in childhood and early adult life, and as the result of injury at all ages.

There are several varieties of cataract.

(*a*) *Zonular or lamellar cataract* is either congenital or commences soon after birth; it is characterized by an opacity of circular form and well-defined outline, situated in the cortical substance of the lens, but at some distance from its surface; the margin, nucleus, and superficial layers of the lens are transparent.

(*b*) *Ordinary congenital cataract* is a bluish-white opacity of the whole lens.

(*c*) *Traumatic cataract* is an opacity of the lens often accompanied by swelling and caused by rupture of its capsule from injury and the subsequent action of the aqueous humor upon its substance.

(*d*) *Posterior polar cataract*, an opacity situated at the posterior pole of the lens; and—

(*e*) *Entirely fluid or diffluent cataract*, caused by changes in the lens secondary to inflammation of adjacent parts.

The variety of cataract met with in diabetes is composed principally of soft material; but if the patient be advanced in years, there is usually a hard nucleus.

Nuclear cataract occurs in persons who have passed the middle period of life and is characterized by the presence of a hard yellowish central portion or nucleus of varying size and density; the nucleus is surrounded by more or less soft cortical substance and is occasionally of a greenish or almost black color, giving rise to what is known as *green or black cataract.*

Diagnosis.—The existence of cataract is easily ascertained by oblique illumination, the pupil having been dilated with atropine previous to making the examination.

Treatment.—The treatment of cataract is entirely operative, no kind of medication being of the least use.

Our object in performing an operation is to open a path for rays of light to pass to the retina. This can be attained in one of two ways, the method adopted depending on the kind of opacity present.

1. In cases (as lamellar cataract) where the bulk of the lens is clear, the opacity being situated in the axis of the normal pupil, very useful vision is procured by making an artificial pupil opposite a transparent portion of the lens. (See "Artificial Pupil.")

2. When the whole lens is opaque, its entire removal must be accomplished.

Varieties of Operation.—Three varieties of operation are performed to secure the removal of the whole lens:

1. The operation for solution or absorption.
2. Extraction.
3. Suction.

Forms of Cataract to which each Operation is Applicable.—As a

broad rule, cataract occurring in persons below 20 is of the soft or cortical form and should be removed by *solution* or *suction;* cataract occurring in persons above 30 (except traumatic cataract) is of the hard or nuclear form and must be removed by extraction.

In the intermediate decade a doubt may arise as to what is the best plan of procedure; in these cases the surgeon must be guided by the general appearance of the cataract. If it appears bluish in color and somewhat swollen, it is probably soft and can be removed by *solution* or *suction;* if there is a distinct yellow reflection from its centre, denoting the presence of a hard nucleus, it should be removed by *extraction.* It must also be borne in mind that loss of time is a very serious consideration with most patients; consequently, a preference must always be given to that operation which will allow them to resume their occupations as early as possible.

Solution, though perhaps somewhat safer than extraction, is always a tedious process, and the more so the older the patient; consequently, preference must be given to extraction in all cases where the condition of the patient's sight is such as to prevent him following his occupation, even though there be no appearance of a hard nucleus. In cases where the cataract is evidently soft and one eye retains useful vision solution is to be preferred to extraction, as the patient can continue at his work during the time that absorption is going on.

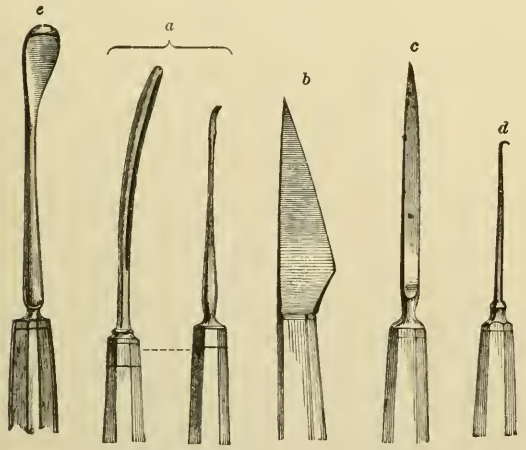
Before performing any operation for cataract we must take care to ascertain that the eye has good perception to light, indicating that the retina is in a normal condition; otherwise, no improvement in vision will result from removal of the lens.

Operations for Removal of Cataract.

Solution.—In the operation for solution the capsule of the lens is opened, and its substance thus allowed to be acted upon by the aqueous humor, by which it is broken up and softened, absorption finally taking place.

The operation can be performed as follows (for the positions of patient and operator see Fig. 111, p. 290): No anæsthetic is needed; the pupil should be well dilated with atropine; the operator, keeping the eyelids separated by the fore- and ring-fingers of one hand and steadying the globe by pressing the second finger gently upon it, should take a cataract needle in the other hand and pass it obliquely through the cornea at such a distance from its centre that any resulting cicatrix will not interfere with vision; the needle should then be pushed on across the anterior chamber into the area of the pupil, its point then depressed and three or four incisions made with it in the lens capsule, so as to divide it freely. Care must be taken to use the needle very gently and not to pass it too deeply into the lens; otherwise, the suspensory ligament may be torn and the lens displaced.

Fig. 120.



Instruments for Extraction of Cataract.
a, Curette and pricker. *b*, Triangular cataract knife. *c*, Straight cataract knife (Graefe's). *d*, Sharp hook. *e*, Scoop.

The capsule having been freely divided, the needle should be carefully withdrawn and a drop of solution of atropine placed between the lids; the only after-treatment required is the constant use of atropine, so as to keep the pupil widely dilated.

If the eye be examined in the course of a few days, white flocculent lens matter will be seen protruding through the opening in the capsule into the anterior chamber, showing that the lens is swelling and undergoing solution.

The operation will probably require to be repeated in about a month or six weeks, and possibly on one or two subsequent occasions, before the whole lens is absorbed. Care must be taken not to do too much at one sitting, or the lens may swell too rapidly and press upon the surrounding parts, giving rise to severe pain, increased tension of the globe, iritis, cyclitis, etc.

Extraction of Cataract.—The object of operations for extraction of cataract is

the removal of the lens through an incision altogether in the cornea, the sclero-corneal margin, partly in the sclerotic and partly in the sclero-corneal margin, or wholly in the sclerotic, the incision being either simple or associated with excision of a portion of iris.

Extraction can be best performed by one of the five following methods: (1) Flap extraction; (2) Small flap with iridectomy; (3) Extraction by oblique corneal section; (4) Linear extraction; (5) Extraction by means of a traction instrument. In the first and third methods no iris is removed; in the second, fourth, and last, iridectomy should be performed either at the time of removal of the lens or some weeks or months previously. All entirely opaque lenses (mature cataracts) may be removed by the first or third methods; all partially opaque lenses (immature cataracts) must be extracted by the second or fourth, a traction instrument being used in any case where great difficulty is encountered or where escape of vitreous has taken place before the lens has been extracted.

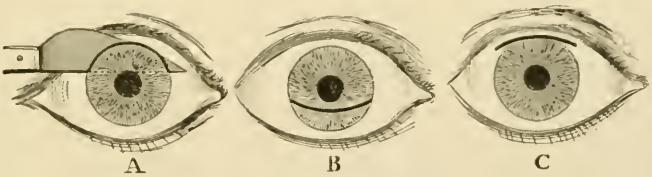
We shall, however, find that in all cases we obtain most uniform success by extraction associated with iridectomy; we should never attempt to extract an immature cataract without first excising a portion of iris, and it is well to do so as a preliminary some weeks before the lens is removed.

Flap Extraction.—The instruments required for flap extraction are a triangular cataract knife, sharp hook, and curette (Fig. 120, *b*, *d*, *a*).

For the positions of patient and operator see Fig. 111, p. 290. No anæsthetic is required; the patient should be requested to look downward, the lids kept open and the eyeball steadied by the operator's fingers as in the operation for solution.

The incision should be made by passing a triangular cataract knife through the outer margin of the cornea at a point just above its horizontal meridian, into and across the anterior chamber, bringing it out through the cornea at a corresponding point on the inner side, and completing the section by pushing the knife onward until its heel cuts out along the upper margin of the cornea (Fig. 121, A).

FIG. 121.



A B C

A, Flap. B, Oblique corneal section. C, Lineal incision.

Incisions for Extraction of Cataract.

This simple onward movement of the knife is sufficient if the incision has been properly planned; but should the cornea have been entered too low down, the knife will not be wide enough to cut out, and then the section must be completed by slightly withdrawing the blade or by a sawing movement. Care must be taken not to withdraw the knife until it has passed some distance through the opposite side of the cornea, or the aqueous humor will escape too soon and the iris fold over the edge of the knife and be wounded.

If the incision has been properly made, it will lie within the corneal margin, and a semicircular flap, including a little less than half the cornea, will be formed.

The section having been finished, the patient should close the eyes gently and be allowed to rest for a moment.

The next step in the operation is the removal of the opaque lens. The upper lid being drawn gently upward and the patient directed to look downward, the sharp hook must be introduced through the wound and the lens capsule lacerated by gently scratching it: the hook should then be withdrawn and the patient allowed to close the eyes for a short time.

The eyes should then be gently opened and the lens removed by lightly pressing the lower lid against the globe, just below the inferior margin of the cornea, with the thumb of one hand, counter-pressure being similarly applied with the forefinger of the other hand at a corresponding point above. If the manœuvre be properly executed, the pupil gradually dilates, the lens slips gently through it into the anterior chamber, and then escapes by the corneal wound. Any prolapse of iris that may occur must be carefully returned with the curette: each eye should then be covered with two pieces of wet lint and a light bandage applied.

Small Flap with Iridectomy.—A flap section should be made by transfixing

the eyeball through the sclero-corneal margin with the straight extraction (Graefe's) knife (Fig. 120, *c*), and then cutting out in the line of the sclero-corneal junction.

The section may be made either upward or downward, and the point of transfixion should be about one-third of the distance from the horizontal corneal meridian to the upper or lower margin of the cornea. The steps of the operation, with the exception of the incision, are exactly similar to those of linear extraction (see below); but should it be thought fit to perform the operation without anæsthesia, no speculum or fixing forceps should be used.

Oblique Corneal Section.—This operation often goes by the name of Bader's or Liebreich's operation, when the section is made downward; Lebrun's "extraction by small median flap," when the section is made upward. It seems to me that the term "oblique corneal section" expresses all and dispenses with much unnecessary prolixity.

The instruments required are a thin straight cataract knife, a sharp hook, and curette (Fig. 120, *c*, *d*, *a*). (For the position of patient and surgeon see Fig. 111, p. 290). No anæsthetic is required, and, with the exception of the incision, the steps of the operation are much the same as in flap extraction.

The incision may be made either upward or downward (Fig. 120, B), by passing the straight knife through the sclero-corneal margin on the outer side at a point (puncture) corresponding to the horizontal corneal meridian into and across the anterior chamber, out at a corresponding point on the inner side (counter-puncture), and then cutting forward by a sawing movement, *obliquely*, through the cornea, midway between the pupil and upper or lower corneal margin—the former if the incision is made upward, the latter if it is made downward. In entering the knife and passing it across the anterior chamber care must be taken to keep its edge directed forward toward that part of the cornea which it is desired to incise; if the knife be rotated in any way after the anterior chamber has been opened, the aqueous humor will escape and the blade become entangled in the iris.

The capsule should be lacerated and the lens removed in the same way as in flap extraction; the position of the incision near the centre of the cornea, however, will not allow the lens to be pressed out immediately, as is done in the flap operation.

Before attempting to squeeze out the cataract its margin must be brought opposite the incision by gently pressing upon the globe above or below, according as the section has been made upward or downward.

The bulk of the cataract having been removed, care must be taken to get away any soft cortical substance or fragments of lens that may be left. The soft matter can be removed by gently rubbing the cornea; small hard fragments must be drawn out by the curette or a small scoop. The whole of the cataract having been removed, the iris—which will in all probability have somewhat prolapsed—must be replaced with the curette, some solution of eserine dropped into the eye to keep the pupil contracted and so reduce the risk of recurrence of the prolapse, and both eyes carefully bandaged.

Linear Extraction.—In this operation the cataract is removed through a linear incision, partly in the sclerotic and partly in the cornea, or altogether in the former; usually associated with iridectomy, performed at the time of extraction of the cataract or some months previously.

By linear incision is generally understood an incision made in the same direction as a straight line drawn from the centre of curvature of the cornea to its circumference (one of its radii). Many modifications of linear incision are practised, but only one will be described here. The instruments required for linear extraction are a wire speculum (Fig. 114), toothed forceps (Fig. 116, *a*), a straight cataract knife, a curette, sharp hook (Fig. 120, *c*, *a*, *d*), iris scissors, and iris forceps (Fig. 117, *b*, *c*).

The operation should be performed thus, and, as in the other forms of extraction, the incision may be made either upward or downward (for position of patient and operator see Fig. 111, page 290): The patient should be thoroughly anæsthetized, the lids kept open by a wire speculum, and, supposing the incision to be made upward, the globe must be drawn gently downward with the toothed forceps, holding the conjunctiva and sub-conjunctival fascia close to the lower margin of the cornea; then with the straight cataract knife puncture and counter-puncture should be made in the *sclerotic*, just beyond the sclero-corneal margin, the knife entering at a point on the outer side of the globe, situated about two-thirds of the way between the horizontal meridian of the cornea and its upper margin, and emerging at a corresponding point on the inner side; the edge of the knife should then be directed nearly straight forward, and by a sawing movement made to cut its way out through the cornea at a short distance from its upper margin (Fig. 121, C).

If iridectomy has not been previously performed, a piece of the iris should next be excised from the upper segment. (See "Iridectomy.")

The next step is to lacerate the capsule. The operator should fix the eye and draw it gently downward with the toothed forceps, then introduce the sharp hook through the incision and freely lacerate the capsule with it. The cataract can then be removed by making gentle pressure with the curette upon the eyeball, near the lower margin of the cornea, the globe being steadied and held in position by fixing the conjunctiva with the toothed forceps.

The nucleus and bulk of the cataract having escaped, the curette should be passed gently over the surface of the cornea from all directions toward the incision, so as to press out any cortical substance that may be left, and if any blood or portions of lens remain in the incision they must be carefully removed, so as to ensure perfect coaptation of its margins; the speculum should then be removed and both eyes bandaged in the usual way.

The incision for linear extraction, as already stated, may be made downward as well as upward, the former method of operating being much the easier and not requiring the aid of an assistant.

The same objections apply to extraction downward as to iridectomy in the same direction, but the results obtained are equally good as from upward sections, and the ease with which the operation can be performed quite counterbalances any objections which may be made on the score of disfigurement.

Extraction of Cataract by a Traction Instrument.—Cataract can be removed by a traction instrument, either through a flap section or a linear incision peripherally situated, iridectomy being performed in either case.

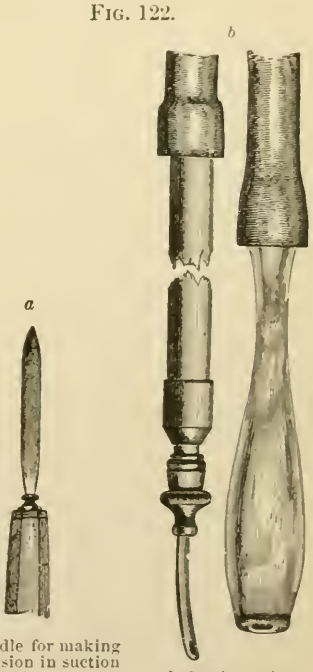
The patient should be thoroughly anæsthetized, and, whichever incision is made, the eyelids should be kept open with the speculum and the globe fixed with the toothed forceps while the section is made and during the subsequent removal of the lens.

The traction instrument employed is either a scoop or a sharp hook (Fig. 120, *e*, *d*).

Removal of Cataract by the Scoop (scoop extraction).—Scoop extraction can be accomplished thus: The section having been made and iridectomy performed, the convex surface of the scoop should be pressed gently upon the more peripheral margin of the incision, so as to cause it to gape somewhat; the instrument should then be passed with the utmost gentleness through the incision, beneath the margin of the lens, along its posterior surface and beyond its posterior pole, until the lens lies well in its concavity, and it should then be carefully withdrawn, carrying the cataract with it, the removal being assisted by gentle pressure on the exterior of the globe.

Removal of Cataract with the Sharp Hook (sharp-hook extraction).—The hook should be passed well behind the lens in the same manner as the scoop, fixed into its posterior surface, and then carefully withdrawn, carrying the lens with it. Two sharp hooks may be used instead of one, and should be fixed into the lens at different points, so as to prevent it rolling round (as sometimes happens when only one hook is used), instead of passing in the desired direction.

FIG. 122.



a, Needle for making incision in suction operation. *b*, Suction tube.

After removal of the lens by either method both eyes should be bound up in the usual way.

Suction.—The removal of cataract by suction is indicated in cases where the lens has become nearly or entirely fluid, as occurs in many instances of traumatic cataract, and frequently after a needle operation has been performed.

The instruments required are a wire speculum, toothed forceps, broad needle, and suction tube (Figs. 114, 116 *a*, 122 *a*, *b*). Before operating, the pupil should be well dilated with atropine. (For position of patient and surgeon see Fig. 111, p. 290.)

It is best, but not absolutely necessary, to place the patient under the influence of an

anæsthetic. The lids should be kept open by a wire speculum, the eyeball fixed by the toothed forceps, and a small linear incision made in the cornea with the broad needle, about midway between its summit and margin, in any convenient position.

The operator should then place the mouthpiece of the suction tube in his mouth, pass its nozzle through the incision and behind the softened lens, and by sucking gently remove as much lens matter as will come away easily. No force must be used; and if any portion of the lens be too hard to pass easily into the tube, it may be left to become absorbed or be dealt with on a future occasion. When as much lens as will easily come away has been extracted, the suction tube should be removed, the speculum taken out, a drop of solution of atropine placed between the lids, and the eyes bandaged in the usual way. The bandage should be continued and the pupil kept dilated with atropine until all irritation has subsided.

Accidents during Extraction of Cataract.

Premature Escape of Aqueous Humor.—If care be not taken in making the section, the aqueous humor may escape too soon and the movements of the knife be hampered by the iris falling forward. Should this happen, the knife must be carefully withdrawn and the section completed with scissors.

Bleeding into the Anterior Chamber.—In some cases hemorrhage from the cut iris or conjunctiva takes place to such an extent as to fill the anterior chamber with blood and hide the cataract entirely from view.

If the blood does not flow out easily on placing the curette between the lips of the incision and making gentle pressure on the cornea, the operation should be discontinued, the eye bound up and left till the blood has become absorbed, unless the lens capsule has been lacerated, in which case the lens *must be removed at all risks*, or it may swell, press upon surrounding parts, set up inflammatory action, cause increase of tension of the globe, and very probably lead to destruction of the eye.

Prolapse of Vitreous Humor.—If any undue pressure be exerted on the globe during extraction, the suspensory ligament of the lens gives way and a prolapse of vitreous follows. Should the prolapse of vitreous occur before the escape of the lens, the cataract should be removed as quickly and gently as possible by the aid of a scoop or sharp hook.

Prolapse of vitreous is more likely to occur if the humor is abnormally fluid. The accident may give rise to no bad results, but is sometimes followed by a form of chronic choroiditis which ultimately destroys the eye.

If vitreous has been lost, great care must be taken to bandage the eye so as to keep the lids immovable and prevent them pressing upon the globe and causing further prolapse.

Displacement of the Cataract.—In some cases, on an attempt being made to press out the lens, the suspensory ligament gives way, and the cataract, instead of coming forward into the anterior chamber, passes behind the iris or sinks backward into the vitreous chamber; it should, if possible, be removed by the scoop or sharp hook. If left within the globe, it will probably act as a foreign body, set up inflammation, and destroy the eye.

After-Treatment of Extraction of Cataract.

Immediately after the operation each eye should be covered with two folds of wet lint secured by a bandage which has been contrived for the purpose by the late Mr. Dunnage[1] of the Central London Ophthalmic Hospital. The patient should then be put to bed, where he should remain for three or four days.

The lint must be kept constantly wet for the first week, and fresh pieces should be applied every two or three days.

On no account should the eye be examined until the end of the first week; if the lids remain in a normal condition, we may rest assured that all is going on well, and opening the eye too early can do no good and may do a great deal of harm.

At the end of a week the eye may be opened and its condition ascertained. Should the section be healed, the anterior chamber re-established, and no signs of inflammatory action present, the sound eye can be safely left uncovered, the one that has been operated on being kept bandaged with dry lint and a large green shade worn over both. At the end

[1] Dunnage's bandage consists of a piece of material of an open texture, through which water will easily run, of such a length as to cover both eyes and leave some to spare. To each end of this piece are attached tapes, by which the bandage is secured.

of three weeks the bandage may be removed from the eye on which extraction has been performed, but the shade or protectors should be worn until all undue vascularity has subsided.

At the end of about two months (if there be no intolerance of light or irritability of the eye) glasses should be ordered, two pairs being given, one for going about and one for reading; convex 13 D will usually be found most suitable for the former purpose, convex 16 D for the latter. But should the patient have been myopic or hypermetropic before the operation, glasses weaker or stronger than these may be required.

This is the usual course of cases of extraction of cataract; all do not, however, go on so favorably.

A day or two days after the operation the patient may complain of severe pain in the eyeball, temple, and brow, and on removing the bandage the lids may be found puffy and red, or perhaps much swollen.

These symptoms always indicate inflammatory changes in some of the ocular structures; the inflammation may be simply an attack of iritis, which will probably proceed to a favorable termination, but may subsequently affect the choroid, a chronic form of choroido-iritis being set up, which leads to softening, and eventually to shrinking, of the globe; the cornea may be inflamed or suppurating, or inflammation and suppuration of all the ocular structures (panophthalmitis) may have set in. (For the treatment of these cases see "Iritis," "Corneitis," etc.)

A not uncommon cause of pain and irritation is the occurrence of entropion of the lower lids; this must be remedied by operation. (See "Operations on the Eyelids.")

Causes of Unsatisfactory Results of Cataract Extraction.

The result of an operation for extraction of cataract may be marred by closure of the pupil consequent on iritis, by obstruction of its area with opaque lens capsule, or by opacity of the vitreous humor.

Occlusion of the pupil should be remedied by making an artificial one (see "Artificial Pupil"); capsular obstructions should be torn through with cataract needles, cut across with scissors, or removed bodily with forceps.

The greatest caution must always be exercised in meddling with opaque capsule, as an operation upon it, especially an attempt to tear it forcibly away, is very likely to be followed by increase of tension, inflammation, or even suppuration of the eyeball.

For opacity of the vitreous humor nothing can be done.

EXTIRPATION OF THE EYEBALL.

Removal of the eyeball is called for under the following conditions:

1. In all cases of injury causing complete disorganization, with collapse of the globe and escape of its contents.

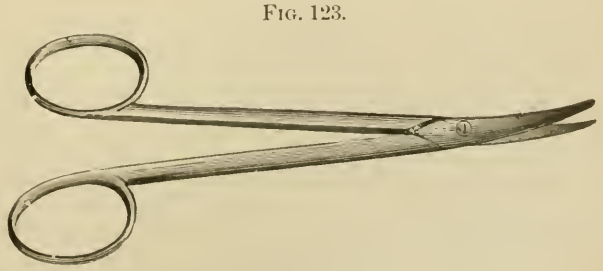
2. In cases where one eye, having been damaged by injury or disease to such an extent as to render it *practically useless*, becomes irritable or painful and the sound eye appears threatened by sympathetic ophthalmia.

3. In cases where an eye lost from injury or disease, and *quite blind*, is a source of annoyance, even though the other eye be not threatened.

4. In cases where the globe has become the seat of malignant disease.

Extirpation of the eyeball should be thus performed (for position of patient and operator see Fig. 111, p. 290): The instruments required are a wire speculum, toothed forceps, a pair of blunt-pointed scissors curved on the flat (Fig. 123), and a strabismus hook. The patient being thoroughly under the influence of an anæsthetic, the operator should place the wire speculum between the lids, then by the aid of the forceps and scissors cut through the conjunctiva all round the cornea as close to its margin as possible; he should then with the strabismus hook take up the four recti muscles, one after the other, and divide them with the

Fig. 123.



Extirpation Scissors.

scissors, either the external or internal rectus being cut at a little distance from the globe, so as to afford a hold for the forceps in the subsequent steps of the operation, and the other three muscles as close to it as possible.

The muscles having been divided, the hook should be made to sweep round the globe, so as to be sure that nothing is left uncut. By pressing the speculum backward the eyeball will become dislocated in front of the lids, and then, being steadied by holding the piece of muscle purposely left with the forceps, the scissors should be passed behind it until their points are found to be in contact with the optic nerve, then slightly withdrawn, opened widely, pressed forward again, and the nerve divided by a single cut.

As soon as the nerve has been cut through, the eyeball will be almost free, being held only by the oblique muscles, which should be divided close to the sclerotic. Should there be free hemorrhage, the speculum may be left between the lids, a piece of sponge pressed firmly into the orbit and secured by a turn of bandage; when all bleeding has ceased, the sponge should be removed with the speculum and two small pads of wet lint and a bandage applied. Should the hemorrhage be but slight, two or three small pads of wet lint must be laid over the closed lids and secured by a bandage in the same manner as in other operations on the eye. In about a month or six weeks an artificial eye may be ordered.

ABSCISSION.

Abscission is the removal of that portion of the eyeball (including the ciliary region) situated in front of the attachments of the recti muscles, these being left intact. The object of this operation is to leave a movable stump on which an artificial eye can rest and be moved in harmony with the movements of the sound one.

Abscission is indicated in staphyloma occupying the whole or greater part of the former situation of the cornea, the remainder of the globe retaining its normal curvature.

The operation should be thus performed (for position of patient and operator see Fig. 111, p. 290): The instruments required are a wire speculum, toothed forceps, strabismus scissors, a triangular cataract knife, a curved needle, and silk. The patient being thoroughly under the influence of an anæsthetic, the wire speculum should be placed between the lids, the conjunctiva divided all round close to the corneal margin (as for extirpation) and dissected back to the desired extent. Then with the curved needle a single suture should be passed through the edge of the divided conjunctiva at five or six different points, so as to surround the wound in it in much the same manner as the string surrounds the mouth of an ordinary bag, and the ends of the silk left hanging on the patient's face.

The staphyloma, the whole of the ciliary body, and sclerotic corresponding to it, should then be removed by transfixing the globe with the triangular knife just in front of the insertions of the internal and external recti muscles, cutting out upward in front of the insertion of the superior rectus and finishing the removal by a sweep of the knife in the opposite direction.

The silk should be then drawn up and tied, by which means the conjunctiva will be made to cover the wound in the globe, and wet lint and a bandage applied. As soon as the parts have firmly healed an artificial eye may be worn.

Abscission should be performed in preference to excision of the globe in children; the presence of the stump left prevents to a great extent the shrinking or non-development of the orbit which will occur if the eyeball be removed entirely.

In older persons excision is generally to be preferred, as the stump left after abscission is very liable to become troublesome, and in the very old is prone to suppurate.

AFFECTIONS OF THE ORBIT.

Protrusion of the Eyeball.—As many of the diseases of the orbit, and to a considerable extent tumors of the eyeball itself, cause more or less protrusion of the globe, it will be well to say a few words on the subject before describing the morbid changes which may give rise to it.

The symptoms are obvious enough and do not require description. The causes are the following:

1. Inflammation within the orbit, either with or without the formation of abscess.
2. Hemorrhage into the orbit.
3. Vascular protrusion of the eyeball.
4. Exophthalmic goitre.

5. Tumors within the orbit, nodes, exostoses, malignant growths, cysts, nævi, etc.

6. Enlargement of the eyeball itself from (*a*) growths, malignant or simple; (*b*) inflammation and suppuration of the whole eyeball (ophthalmitis).

7. Paralysis of its muscles, allowing the globe to drop forward and thus assume an unusual prominence.

Double vision is *generally* complained of in protrusion of the eyeball. The ill-effects of the abnormal position are seen both in the globe itself and in the lids. Should the protrusion be so great that the lids cannot be closed over the eyeball, the cornea will be left unprotected, and may become opaque and afterward ulcerate or slough. If the protrusion continue for long, the lids become distended and flaccid, their movements being much impaired; the tear puncta may also become displaced, giving rise to continual watering of the eye.

Treatment.—In all cases where the eyeball is healthy care should be taken to protect the cornea from injurious exposure by drawing the lids over it and keeping them fixed by a compress and bandage, but in extreme cases the edges of the outer third of the lids must be pared, united by sutures, and allowed to heal firmly together.

Inflammation within the Orbit.—Inflammation may affect the soft tissues within the orbit, the periosteum, or the bone itself; it may end in resolution, the parts returning to their natural condition; chronic thickening may result, causing more or less permanent protrusion and impairment of the movements of the eyeball, or abscess may form, and in the case of periostitis or ostitis caries and necrosis of the bony walls may supervene.

Symptoms.—Inflammation within the orbit is accompanied by more or less febrile disturbance, pain of a throbbing character, much increased by pressure, swelling of the conjunctiva and lids, more or less prominence and impaired movement of the eyeball, intolerance of light, and watering of the eye; it may be the result of cold, injuries, or general diseases, as erysipelas and (in the case of periostitis) of syphilis, or may come on in debilitated states of the system, during recovery from acute diseases (scarlet fever, measles, etc.), or from over-lactation. It is not easy to distinguish inflammation affecting the soft parts only from inflammation of the periosteum or bone.

Treatment should consist in allaying pain and inflammation by means of opium internally, fomentations of poppy-heads to the affected part, leeches to the corresponding temple (two to six in number), and rest in bed in a darkened room; any general medical treatment which may appear most applicable should also be employed.

For instance, if the patient be strong and healthy, low diet, purgatives, etc. should be had recourse to; if weakly, as during recovery from some acute disease, tonics and good diet should be prescribed. Should the patient be the subject of syphilis, this should be treated.

Abscess.—Should the inflammation go on to the formation of abscess, the symptoms are aggravated, the conjunctiva becomes more swollen and in some cases almost covers the cornea, the lids are greatly swollen and red, the prominence and impairment of movement of the eyeball increase, and rigors may occur. Vision becomes misty, and in some cases all perception of light is entirely lost. After a time fluctuation may be detected; if left to itself, the abscess will burst, the pus being discharged either through the skin or conjunctiva. The abscess having been emptied, in favorable cases the swelling will disappear, the eyeball resume its natural position, and the opening heal. But in some cases, especially if the suppuration be associated with caries and necrosis of the bone, the abscess will remain open or the orifice alone heal, the sac again becoming filled with pus.

Treatment.—As soon as the surgeon feels satisfied of the existence of pus in the orbit it should be evacuated. If fluctuation can be detected, the diagnosis is easy enough, but even if this cannot be done and suppuration is suspected, an exploratory puncture should be made, when the escape of pus will clear up any doubt.

The best method of opening an abscess in the orbit is that recommended by Mr. Hilton for evacuating pus situated at a depth from the surface amongst important structures. The operation should be performed as follows: An incision having been made, either through the skin or conjunctiva, at that part where the eyeball appears most thrust away from the wall of the orbit, a grooved director should be thrust in (the surgeon bearing in mind the direction of the wall along which he is passing the instrument and the depth of the orbit). As soon as pus is seen escaping along the groove of the director a pair of small dressing forceps should be passed along it until their points are within the abscess; the blades should then be separated slightly, and drawn out whilst so separated; a ragged

opening will thus be left, which is not likely to close too soon, and the danger of cutting important structures will be obviated.

The greatest care must always be taken not to injure the eyeball. As the operation is very painful, an anæsthetic should be given.

Immediately after the operation search should be made by means of a probe for diseased bone or foreign bodies. If a foreign body or loose sequestrum be detected, it should be at once removed; diseased bone, if still firm, may be left to itself, and will either come away spontaneously or may require removal at a later period. If the opening appear inclined to close too soon, it should be kept open by means of a piece of lint passed into it; only light water dressings need be applied.

Periostitis or Ostitis followed by Caries and Necrosis of the Walls of the Orbit.—The symptoms of periostitis or ostitis going on to caries or necrosis are similar to those above described, excepting, perhaps, that the pain is more severe and often aggravated at night. This form of inflammation should always be suspected in persons suffering from syphilis, and occasionally nodes may be met with at the margin of the orbit or on the forehead; their existence should always lead the surgeon to suspect that the inflammation within the orbit is periosteal. When the abscess has formed and burst or has been opened, the seat of inflammation becomes evident from the character of the pus, which is of that peculiar unhealthy and bad-smelling variety met with in abscesses connected with diseased bone, as well as from the condition of the opening, which remains patent and is surrounded by large unhealthy granulations, and from the fact that the bare bone can be felt with a probe passed through the opening.

Caries and necrosis usually end in recovery after a time, the diseased bone being thrown off and the sinus becoming closed. The disease generally attacks the margin of the orbit and often leaves cicatrices, which cause great disfigurement and deformity of the eyelid. Should caries or necrosis occur deeply in the orbit, the results may be most serious, the optic nerve becoming affected and vision lost, or the disease may spread to the interior of the skull, set up meningitis, and cause death.

Treatment.—In the earlier stages the treatment should be the same as that described under inflammation and abscess of the orbit; but when the abscess has burst or been opened, its cavity should be syringed out daily with some mild disinfecting solution; care must be taken to prevent its too early closure, by means of a piece of lint pushed into the sinus; exuberant granulations should be kept down by the application of nitrate of silver, and distortion of the lids, if likely to occur, must be prevented by uniting their edges. (See "Operations on the Eyelids.")

If any pieces of bone are found loose, they should be removed by operation.

Hemorrhage into the Orbit.—Orbital hemorrhage may depend upon the spontaneous rupture of a vessel within the orbit, and, should it be considerable, may produce displacement of the eyeball. The blood may become diffused and appear beneath the conjunctiva, being subsequently gradually removed by absorption; occasionally, however, the clot becomes encysted, and permanent displacement of the eyeball results. Hemorrhage into the orbit also occurs in fracture of its walls, frequently to a considerable extent, subconjunctival ecchymosis being a prominent symptom in some cases of fracture of the base of the skull extending through the roof of the orbit.

Hemorrhage sufficient to cause displacement of the eyeball has occurred after the operation for strabismus.

Treatment.—In cases of spontaneous hemorrhage light pressure should be applied to the eye by a pad of lint or cotton-wool and a bandage. Where excessive hemorrhage occurs after operations for strabismus, a large pad of lint should be placed on the closed lids and firm pressure by means of a bandage kept up for a few hours after the operation. Hemorrhage from fracture of the orbital walls is only of secondary importance to the injury which caused it, and may be left to itself; it is of more interest to the general surgeon than to the specialist.

Vascular Protrusion of the Eyeball.—This is the name applied, and very justly, by Mr. Thomas Nunneley (*Medico-Chir. Trans.*, vol. xlviii.) to a set of cases formerly considered to belong to the class of "aneurism by anastomosis," but which, Mr. Nunneley shows, differ in many essentials from the latter affection, both in their clinical aspect and history. He has also had opportunities of verifying his diagnosis by post-mortem examination, and in no case has he met with an instance of the above-mentioned affection due to this cause. Mr. Nunneley has reported in all seven cases, and mentions some ten or twelve others described by various writers. The cases reported are chiefly either instances of traumatic aneurism or aneurism arising spontaneously from rupture

of a diseased artery in an elderly person, but in one case a cancerous growth was found involving the orbit and other parts.

The symptoms complained of by the patient are noise in the head and feeling of tension, singing in the ears, pain in the orbit and eyeball, all of which are aggravated by stooping or exertion, but are, nevertheless, most annoying at night. These symptoms are accompanied by more or less protrusion and impaired mobility of the eyeball, dimness of vision, much congestion, principally venous, of the eyelids and conjunctiva, and chemosis, pulsation (which may be controlled by pressure on the carotid of the same side) in any part of the orbit and communicated to the eyeball, and often a bruit heard on auscultation over the brow or other parts immediately adjoining the orbit.

In most cases these symptoms have come on at a varying time after some injury to the head, or have occurred spontaneously and suddenly.

The morbid changes met with in the three cases examined after death by Mr. Nunneley were, in one (in which the disease commenced spontaneously, and the patient died sixteen days after ligature of the carotid), a dilatation of the carotid at the point of giving off the ophthalmic branch, the dilatation being filled with and surrounded by coagulum; the ophthalmic artery itself was somewhat dilated, its coats thickened, and atheromatous in parts; two of its branches were much dilated and filled with clot. In another case, also of spontaneous origin, a circumscribed aneurism of the ophthalmic artery close to its origin was discovered. The third case was found to be one of cancerous disease within the orbit associated with cancerous tumors in other parts of the body.

In the majority of cases of "vascular protrusion" of the eyeball the disease is not within the orbit, but intracranial, the protrusion being dependent on obstruction to the return of venous blood and analogous to the swelling and congestion seen in the limbs when the main artery is affected by aneurism.

It is easy to understand how in a small and firmly-bound space like the cavernous sinus a very insignificant dilatation of the commencement of the ophthalmic artery, or of the carotid itself at any point within the sinus, or a small hemorrhage from either, may prove a most serious impediment to the return of venous blood—much more so than the same amount of disease situated in the cavity of the orbit itself.

Nævus, as is well known, is not unfrequently met with in the orbit, but is usually easily enough diagnosed. (See p. 319.)

A case of traumatic aneurism of the orbit—which is, I believe, unique—came under my observation in September, 1873.

The patient, a young gentleman, was some two months previously opening a hamper in which were some bottles of soda-water; one of these burst, and a large piece of glass was driven with considerable force into the left orbit, inflicting a wound in the upper eyelid just external to the internal angular process of the frontal bone; the glass dropped out; sharp arterial hemorrhage occurred, which was stopped by pressure; much swelling and ecchymosis of the lids followed. The wound healed, the swelling and ecchymosis disappeared, and all seemed to be going on well; but shortly before being seen by me the eyeball seemed to be somewhat protruded and considerable congestion of the eyelids and conjunctiva was noticed. When first seen by me, there was much venous congestion of the eyelids and conjunctiva (no chemosis), marked protrusion of the eyeball in a direction somewhat outward; a small pulsating tumor could be distinctly felt near the inner angle of the orbit; a marked thrill was communicated to the eyeball, which could be felt on placing the hand upon the closed lids; a buzzing in the head was complained of, especially on stooping; there was a small linear cicatrix over the pulsating tumor, marking the seat of the original injury.

Ophthalmoscopic examination showed an extremely dilated and tortuous condition of the retinal veins, but detected no pulsation; there was no impairment of vision.

Pressure on the left carotid at once stopped the pulsation and caused considerable decrease of the venous congestion.

Aneurismal varix was diagnosed. Perfect rest and pressure applied directly to the part were tried for some months without benefit. It was at length determined by the patient's medical attendant to perform an operation; accordingly, an incision was made over the tumor, and several fair-sized vessels which appeared to communicate with it were tied. The wound healed kindly.

I saw the patient again at the beginning of the summer of 1874. The congestion had disappeared, the pulsation ceased, and the eyeball had returned to its natural position, the only sign of the disease remaining being a small linear cicatrix in the upper eyelid

and a slight thickening near the inner angle of the orbit in the position previously occupied by the pulsating tumor.

TREATMENT.—Rest, low diet, with depressing remedies, as cold applied locally and the administration of digitalis or antimony, should always have a fair trial. Pressure applied locally by means of a pad and bandage should also be employed if it can be borne.

These means failing, recourse must be had to digital pressure of the carotid, kept up for some hours, the patient being under the influence of an anæsthetic, as pressure in the neck gives rise to such intolerable pain that even the most resolute can only bear it for a few minutes at a time.

As a last resource a ligature must be applied to the common carotid on the same side as the disease.

This operation was performed in all but one of Mr. Nunneley's cases with the best results.

Should a case similar to that reported in this article occur, the operation which proved so successful in it should be performed.

EXOPHTHALMIC GOITRE (BASEDOW'S DISEASE).

This disease is characterized by protrusion of the eyeball, impairment of the movements of the lids, and diminished sensibility of the cornea and conjunctiva, accompanied by disturbance of the heart's action and systolic murmurs in the heart and great blood vessels of the neck, together with dyspnœa and enlargement of the thyroid body.

TREATMENT.—Should the protrusion of the eyeballs be very extreme, ulceration and perforation of the cornea may occur; this may be guarded against by protecting the cornea with a small pad and light bandage applied over the closed lids, or the outer third of the palpebral aperture may be closed by operation. These patients are, however, extremely intolerant of anæsthetics. General medical treatment should also be employed; for this the reader is referred to works on general medicine.

TUMORS OF THE ORBIT, ORBIT AND EYEBALL, AND EYEBALL ALONE.

Tumors of the orbit alone are: exostoses, nævi, cysts, nodes, and malignant growths. Those of both orbit and eyeball are usually malignant and commence primarily either in the eyeball or some of the other structures within the orbit; those of the eyeball alone are also for the most part malignant, but simple sarcomatous and cystic growths are occasionally met with.

TUMORS OF THE ORBIT ALONE.

Exostoses.—These are of two kinds, either hard, ivory-like masses consisting of compact bony tissue, or soft spongy growths of an open cancellated structure.

Bony tumors are generally met with as hard more or less circumscribed outgrowths of varying size, growing either from the bone itself or from the periosteum. They affect the orbit alone or may project into neighboring cavities—a fact which should be borne in mind when attempting their removal.

TREATMENT.—Should exostosis of the orbit give rise to inconvenience, it may be removed by operation. An incision should be made, parallel with the margin of the orbit, over the most prominent part of the growth, which, having been thoroughly exposed, should be removed in any way which may appear the most effectual, the greatest care being taken to guard the eyeball from injury, and, if possible, to preserve the continuity of the lachrymal canaliculi and position of the tear puncta. In the removal of the hard ivory exostosis the greatest difficulty will be experienced, some hours' patient work with chisel and mallet being occasionally required. The operation can, however, be greatly facilitated by boring through the base of the tumor with a drill worked by a "dental engine." The surgeon who undertakes the removal of such a growth should be aware of the extreme difficulty to be surmounted, and arm himself with a corresponding amount of patience and perseverance before commencing the operation. The soft, spongy growths are much more easily removed: the tumor, having been thoroughly exposed, can usually be broken off with strong forceps. Should the growth be on the inner side of the orbit and much force be used in its removal, the cavity of the nose may be opened, and the operator may be rather alarmed at seeing large quantities of air blown out with the blood. This accident, however, need occasion no uneasiness, as it makes no difference to the prog-

ress of the case; nevertheless, care should always be taken not to fracture the orbital walls. Should the fracture take place in the roof instead of in the inner wall, the consequences would be most disastrous, as the cavity of the cranium would be opened.

Nævi are not uncommonly met with in or about the orbit, situated generally near its margin, or in the eyelids, but sometimes growing deeply in the orbital cavity. They present much the same characters as in other situations, being soft to the touch, of a bluish color, and becoming harder and more tense during crying or straining.

TREATMENT.—The nævus should, if possible, be excised. Subcutaneous ligature is most applicable in some cases, but care should be taken to prevent, as much as possible, subsequent cicatrization, in consequence of the deformity it may produce in or about the eyelids. Other cases may be treated by setting up adhesive inflammation within the growth, by the use of the galvanic or other cautery, or by passing a number of small setons soaked in perchloride of iron through its substance. The setons should be left in until they have set up a slight amount of suppuration. Injection of the growth with perchloride of iron, solution of tannin, or chloride of zinc may also be tried; but the greatest caution is necessary, as the operation has occasionally been followed by the sudden death of the patient.

Cysts.—Various kinds of cysts are met with in and about the orbit, the most common being the congenital dermoid cyst. (See "Operations on the Eyelids.") Simple cysts, probably the remains of hemorrhages, and cysts connected with the lachrymal gland, are also met with. Hydatids have occasionally been seen.

Nodes.—Periosteal nodes are not unfrequently met with; they occur as hard, and sometimes painful, tumors, usually situated somewhere about the margin of the orbit, but sometimes deep in its cavity. The existence of a node deep in the orbit should always be suspected in cases of paralysis of any of the ocular muscles, displacement of the eyeball, etc., if these symptoms be associated with nodes on the forehead or margin of the orbit and other symptoms of syphilis. Nodes gradually disappear under anti-syphilitic treatment.

Sarcomatous or cancerous growths may be met with; and when possible, they should be removed by operation.

TUMORS OF ORBIT AND EYEBALL.

The tumors affecting the orbit and eyeball are malignant growths which have usually commenced within the eyeball and afterward perforated the tunics and implicated the tissues of the orbit. They are generally of the variety known as melanotic sarcoma.

The appearance of the tumor varies according to the stage of growth at which it has arrived. In an advanced case a large fungoid mass, of a dirty grayish or brownish color, having a foul surface covered in parts with dark scabs, in others discharging thin unhealthy matter occasionally mixed with blood, will be seen protruding between the swollen and distended lids. On closer examination the eyeball (as such) will be found nearly destroyed, portions of the sclerotic alone remaining in their proper position. The movements of the globe are much impaired or altogether wanting, the growth having implicated the whole of the tissues of the orbit in one malignant mass. It is curious how the growth, as it advances beyond the limits of the eyeball, loses its melanotic character and becomes lighter-colored.

The constitutional disturbance in these cases is often severe, especially when the disease is far advanced.

TREATMENT.—The treatment of these growths depends much on the extent to which the tissues of the orbit are implicated and the state of the patient's health.

If the tumor is fairly circumscribed, so that there appears to be a reasonable hope of removing the whole, and the patient is in such a state of health as to preclude the likelihood of similar deposits in other parts, extirpation of the eyeball and other diseased tissues should be performed, any portions of growth that may be left being afterward destroyed by some escharotic. But should the orbit be so filled by cancerous deposit that there appears to be little hope of removing the whole growth, more especially if the patient is in a cachectic condition, no operation should be thought of, and the surgeon must content himself with palliative treatment, as opiates to relieve pain and attention to the general health.

Tumors of the Eyeball.

1. **Glioma.**
2. **Sarcomata,** melanotic, round, and spindle-celled.
3. **Carcinoma.**
4. Tubercular deposit.
5. Pseudo-glioma.

Glioma is most commonly met with in children, but occasionally in older persons.

Sarcomata, melanotic, round, or spindle-celled, are usually met with in persons of from fifty to sixty years old, and occasionally in early adult life. The melanotic is the most common form.

Carcinoma has been met with in persons past the middle period of life, but its occurrence is rare.

Glioma occurs most commonly in children; it commences in the retina and presents the following appearance; The patient will generally be healthy-looking and present no signs of cachexia; attention has been drawn to the eye from a peculiar glistening appearance of the pupil (cat's eye). On examination, the surgeon will notice the peculiar reflection through the pupil, which is generally somewhat dilated, but movable, in the earlier stages. Examination both by means of the ophthalmoscope and by lateral illumination will show a whitish growth projecting into the vitreous chamber, either as a single prominence or in nodules; the growth will gradually increase, its surface become covered with blood vessels, the retina be displaced, and sight soon entirely lost.

As the disease progresses the tension of the globe increases; the pupil becomes widely dilated and fixed, the iris pushed forward and nearly in contact with the cornea, and the lens opaque, preventing a view of the interior of the eye. The whole globe now gradually enlarges, frequent inflammatory attacks occur, the sclerotic becomes thinned, and at last, if the growth is allowed to remain, a slough forms near the centre of the cornea, which ruptures, and a fungoid bleeding mass protrudes.

The increase of the growth now becomes much more rapid, and it may grow to a considerable size in a short time.

As soon as the growth becomes exposed to the air it commences to discharge thin sanious pus and blood and becomes more or less coated with a dirty yellow scab. The eyelids become inflamed and swollen, sharp attacks of hemorrhage may take place, the general health suffers, and the patient dies from exhaustion or from extension of the disease to the brain.

Glioma in its early stages is likely to be confounded with tubercular deposit within the eyeball or pseudo-glioma, but it is not likely to be thus mistaken after perforation has occurred.

Treatment.—The only treatment of glioma is extirpation of the globe, and this should be done as soon as the nature of the disease has been made out; but, however early the operation may be performed, the disease is almost certain to return either in the optic nerve or in the brain.

Melanotic sarcoma, or black cancer, affects persons of advanced age; it is a variety of soft cancer, characterized by the development of black pigment-cells; it may grow either from the interior or exterior of the eyeball, but generally commences in the choroid. It is said not to be so liable to recur as glioma. Round- and spindle-celled sarcomata also commence most commonly in the choroid.

Treatment.—Early extirpation. In all cases of excision for malignant growths the optic nerve must be cut back as far as possible.

Carcinoma, as above stated, is rarely met with.

Tubercular Deposit.—The appearance of this deposit within the eyeball closely resembles that met with in the early stages of glioma. The patients are usually children. The deposit is in the choroid; there is the peculiar glistening appearance of the pupil noticed in glioma, and blood vessels may be seen upon the surface of the growth; the retina is more or less displaced by fluid between it and the choroid and floats in the vitreous chamber. The growth goes on increasing; the pupil becomes dilated, its mobility is destroyed; the lens becomes opaque, the sclerotic thinned, the whole eyeball somewhat enlarged, and suppuration may occur; supposing the disease to have gone on up to this point, there is nothing by which it can be distinguished from glioma.

Diagnosis.—Now, however, the difference becomes manifest: the growth, instead of increasing, destroying the cornea, and projecting from the eyeball, commences to shrink, and with it the eyeball, which becomes soft and is at length reduced to a small irregular

mass. The growth of tubercular deposit may become arrested at any time, and the shrinking of the eyeball commence; in this, again, it differs from glioma.

Appearances somewhat similar to glioma are also produced by inflammatory deposit in the vitreous; the disease has received the name of "Pseudo-glioma." It is possible to distinguish the two by the fact that in glioma the anterior chamber is in the early stages of good depth; in pseudo-glioma it exists only at the periphery. Moreover, in pseudo-glioma there are often evident signs of past iritis and the tension of the globe is below par.

Treatment.—Tonics and good generous diet. In all doubtful cases and in those in which there is much pain the eye should be incised.

Inflammation and Suppuration of the Eyeball (Ophthalmitis).

Ophthalmitis is usually the result of injuries, especially of those complicated by the lodgment of a foreign body within the globe; it unfortunately not infrequently follows operations for cataract, and is occasionally met with during erysipelas, pyæmia, scarlet fever, etc., and sometimes in women after confinement, especially if the strength is lowered by over-lactation. The disease may begin in any of the structures of the eyeball. Should it commence in the cornea and iris, the former will become cloudy, and soon abscesses will form in its substance, the iris likewise becoming discolored and covered with pus. The suppuration may stop short here, the cornea and iris being alone destroyed, and the eyeball left with some perception of light. (See "Suppuration of Cornea" and "Iris.") Should the disease, however, commence in the deeper structures of the eyeball, rapid impairment of vision will take place, all perception of light being lost in perhaps a few hours.

If the pupil be clear, pus may be seen behind it, but in most cases all appears dark; the movements of the eyeball are much impaired and the lids and conjunctiva considerably swollen. As the disease advances the eyeball becomes enlarged and its tension increased, and if left to itself will rupture and discharge its contents, much to the patient's relief. The globe afterward shrinks to a small button-like stump. Pain is very severe in many cases, but occasionally is altogether wanting. Suppuration of the eyeball rarely sets up sympathetic changes in the fellow-eye.

Treatment.—This depends upon the cause of the disease and whether one or both eyes are affected. Should the inflammation depend upon the lodgment of a foreign body, this should be removed without any reference to its position or the state of vision; if the eye have still good perception of light, it will certainly be destroyed, and, whatever difficulties the surgeon may encounter, he cannot possibly make matters worse, and he should not hesitate an instant or he will lose his chance of preserving any sight that may be left. Any foreign body having been removed, the surgeon's next care should be to relieve pain, and, if possible, check the progress of the inflammation.

These indications are best carried out by the application of leeches (if the patient be strong and can bear blood-letting), by opium internally, and by the constant use of sedative fomentations, the best being the Fotus Belladonnæ (made by dissolving a drachm of extract of belladonna in a pint of warm water) mixed with an equal quantity of Fotus Papaveris (made by boiling an ounce of poppy-heads in a pint of water); a piece of rag or lint soaked in this mixture as hot as it can be borne should be kept constantly applied to the affected eye. Poultices may also be employed. Most patients will require the administration of a fair amount of stimulant, good food, with iron and quinine.

When suppuration has been fairly established and all perception of light lost, the eye ball must be treated as an ordinary abscess and the pus let out by incision.

CHAPTER IX.

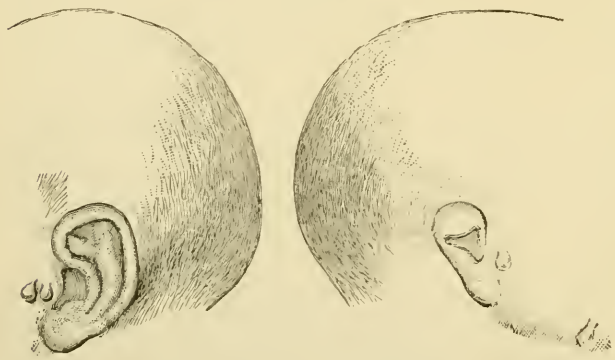
AFFECTIONS OF THE EAR.

By Mr. LAIDLAW PURVES.

AFFECTIONS OF THE EXTERNAL EAR.

Malformations.—The malformations of the external ear which are met with are very varied, extending from cases in which there occurs an entire want of the auricle to those in which the possession of a double set is seen. In cases where the hearing is not affected by the malformation the surgeon may be consulted as to the propriety of an operation with a cosmetic view. He must in these regulate his opinion by the usual surgical rules, having regard to any possible interference with the acuteness of hearing which an operation might entail. The most common malformation is a congenital, either partial or entire, want of the auricle, with a failure of the meatus auditorius externus or an occluded meatus, the lobules of the ear occasionally being displaced either on to the neck or cheeks (*vide* Fig. 124). But the auricle may be absent from injuries and the meatus closed from otitis, lupus, etc. Such defects do not necessarily occasion an absence of the hearing-power, and cases are on record in which patients with this defect could hear sufficiently well to hold conversations with those to whose voices they were accustomed. Before deciding to operate in such congenital cases it is advisable to keep the child under observation for some time for the purpose of noting if any signs of hearing are developed.

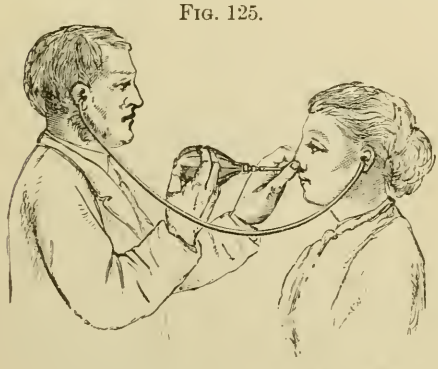
Fig. 124.



Drawing of Occluded Ears. (Taken from a female patient of Mr. Bryant's, aged three months.) Right auricle smaller than left, and more deformed. The pendulous bodies contained cartilage. The child had likewise a pendulous outgrowth on left nostril.

Treatment.—Should it be determined to operate, the point of operation may now and again be fixed by passing a current of air through the Eustachian tube and noting the point at which the impingement of air at the end of the *cul-de-sac* is heard best. This is accomplished by using what is generally called "Politzer's method" (Fig. 125), which consists in passing the soft nozzle of a caoutchouc bag filled with air into one or other nostril of the patient, and while he swallows a mouthful of water compressing the nostrils with the fingers of the left hand, so as to prevent the exit of air through them. At the same moment the right hand forcibly expels the air from the bag in such a way that, finding no passage open except the Eustachian tubes, it rushes up them, passes into the tympanic cavity, and pushes out the membrana tympani. It is this sudden rush of air against the external wall of the cavity which the surgeon listens for by means of a tube of india-rubber passing from the meatus of the patient to that of the surgeon. In cases of absence of the meatus a stethoscope may be used, by which the surgeon determines at which point the air impinges most forcibly, and at this point he makes his opening. If hard and bony at this spot, the trephine will

Fig. 125.



Politzer's Method of Inflating the Middle Ear.

be necessary; if soft, the knife will suffice, making a crucial opening and keeping the opening patent by means of tents or other foreign bodies. In congenital cases the opening ought to be made very carefully, watching for the membrana tympani; but should there be no membrane found on cutting down to the usual position of such, it is advisable to allow the artificial opening to close again. If the deafness before operating is very great, it is probably better to discountenance any operation, as the results of interference with congenital malformations of the ear have generally been by no means satisfactory.

Cutaneous Affections of the External Ear.—Hypertrophy from chronic inflammation, eczema (acute and chronic), herpes, impetigo, pemphigus, erysipelas, affect the auricle and have much the same appearances, follow the same course, and are amenable to the same treatment, as in other parts of the body.

TREATMENT.—Particular attention ought to be paid to any skin affection which may be present in the neighborhood of the auricle, especially in the hair, careful note being paid to the sort of pomade or other application the patient uses for cosmetic purposes. The meatus auditorius externus ought to be cleared once daily by a lukewarm water injection of any collection of epidermis or cerumen, which is apt to be of a greater quantity than normal during the progress of the skin affection.

INJURIES TO THE EXTERNAL EAR.

Injuries to the external ear are by no means rare, but, happily, if confined to the auricle, they affect the hearing of the sufferer but slightly. Under the usual treatment they generally do well, care being had to make as perfect an adjustment of the parts as possible. In 1866, Mr. Bryant treated a girl of twelve years of age for the effects of an ulceration of the external ear some years previously. The condition of the ear is indicated in the accompanying engraving (Fig. 126). By paring the edges of the pendulous portions of the auricle and the skin covering over the parts behind, a good-looking entire ear was made, with great addition to her comfort.

FIG. 126.

Drawing 224[39½]

The tumors of which the auricle may be the seat are the othæmatomatous, gouty, fibro-plastic, fibro-cartilaginous, sebaceous, erectile, epitheliomatous, and sarcomatous. The fibro-plastic or cheloid has been already alluded to as occurring in the lobulus of the ear after the operation of puncture. I have seen many such, the largest having been the size of a walnut (Fig. 128). They generally do well after excision, but if not thoroughly removed will grow again. The othæmatomatous requires special mention, but the others are to be recognized and treated as in other parts of the body.

Hæmatoma.—Idiopathic hæmatoma auris, or vascular tumor of the ear, consists, according to the latest trustworthy authorities, of a degenerative morbid process induced by general disturbances of nutrition. The cartilage of the auricle is its seat, but the pathological appearances differ, as some have found the perichondrium separated from the cartilage, while others have found "pieces of the cartilage attached to the perichondrium." In other cases the cartilage has been found thicker but no harder than natural, the thickened part presenting no appearance of a cyst, but under the microscope showing hypertrophied cartilage cells and intercellular matter. This idiopathic hæmatoma commences by a flushing of the auricle, which becomes hot and painful. In a few hours an effusion of blood takes place, which, generally commencing in the concha, gradually spreads over the auricle, feeling firm to the touch, but allowing of fluctuation being detected if looked for with care (Fig. 127). It is believed to be peculiar to patients suffering from different forms of insanity, general paralysis having the largest share, melancholia, acute and chronic mania, and dementia following in the order named. Dr. Hun thinks that the affection obtains such an exclusive position amongst the insane that any one suffering from hæmatoma auris, although sane at the time of observation, ought to be suspected of insanity.

That the affection occurs in persons who have no hereditary history and show no symptoms of insanity is undoubted, but whether the pathological changes at the seat of the tumor are the same in those cases or differ in the other cases in which there is a history of traumatic injury is yet undetermined, though I am inclined to believe, from the cases which have come under my own notice, that those resulting from injury do not arise from the same pathological changes.

TREATMENT.—The modes of treatment recommended by different authorities vary. Gruber recommends evacuation of the fluid and coagula and the after-use of a compress

bandage, while Wendt relates a case where vascular tumor recurred twice after incision, but passed off under lead-water applications and compression. I have tried the different methods proposed, once passing a seton through the tumor and keeping up a slight discharge from it, and find them get well under all the different methods. Since the application of astringent lotions and a compress is less alarming to the patient and seems as effectual, I am inclined to follow it in future cases, keeping up the compression by a modified letter clip applied to the ear, padding the arms of the clip, so as to prevent injury to the skin of the auricle.

Report by Dr. Goodhart on Cheloid Tumors of the Ear.

The small tumors or thickenings of the skin which usually go by the name of cheloid (Alibert), are of inflammatory nature, with more or less tendency to become fibrous.

Fig. 127.

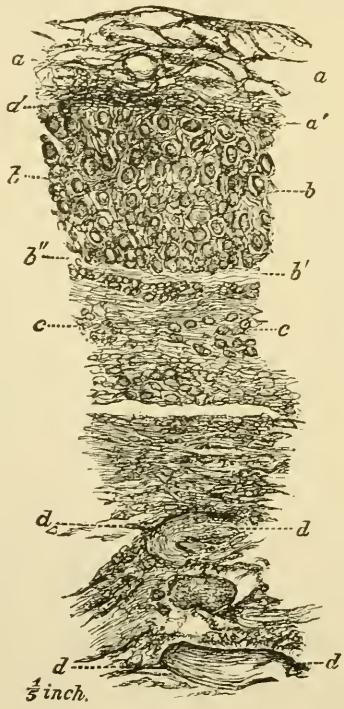
Hæmatoma Auris.

Fig. 128.

Cheloid Tumor of Ear.

Fig. 128 gives the microscopical appearances of one of those cheloid tumors, from the pencil of Dr. Goodhart.

Fig. 129.



a Horny layer of epidermis.

a' Its limit.

b Cutis vera.

b' Limiting layer of epithelial cells.

c Corium of fibrous tissue with nuclear elements scattered through it. They are apparently inflammatory, for they do not alter the tissue in any way; they merely lie in the spaces.

d Hyaline bands of fibrous tissue, taking the carmine stain well, but having no definite structure.

These drawings (Figs. 128, 129), made from a section of one of these growths in the lobule of an ear which had been pierced for an earring, show the microscopical characteristics. Its macroscopical appearance was that of a fibrous tumor. It will be seen that, in addition to newly-formed tissue, there is also a great deal of nuclear germination going on.

Affections of the External Meatus.

To examine the external meatus, it is usually necessary to employ a speculum for the purpose of straightening and widening the canal, and so allowing of the passage of rays from a natural or artificial light. The specula are formed of silver or caoutchouc and are of various forms. The silver speculum of Wilde with a round aperture at the narrow end will be found as convenient as any, it being necessary to have three or four different sizes. If available, sunlight, either direct or reflected from a white cloud, is, I think, the best mode of illumination, as it gives different tints of the meatus and tympanic membrane more truly than any artificial light. Seating the patient near a window, with the ear to be examined away from the window, you receive the rays on a mirror either held in the hand or placed on the forehead, and reflect them into the meatus by inclining the mirror to the required angle. If you use the rays direct from the sun itself, it is neces-

sary that a plane mirror should be used, the usual concave mirror soon causing such an amount of heat to be felt at the spot on which the reflected rays are thrown that the patient cannot endure a long examination. Should sufficient daylight not be obtainable, an argand burner, with or without a bull's-eye lantern placed over it, will act as a good substitute. Having arranged your flood of light so that it falls on the auricle and external meatus, you take the superior and posterior part of the auricle between the middle and index fingers of the left hand, and, pulling the auricle backward and upward, you widen more fully the lumen of the meatus, into which you introduce, by the right hand, the small round end of the speculum. Passing it gently in by a slightly rotating motion, you reach a spot where, there being no foreign body to occlude the view, if the meatus is of a normal width, the tympanic membrane will be exposed to view. On accomplishing this, the external edge of the speculum is passed to the care of the thumb and index fingers of the left hand, which move it in different directions, so as to throw rays on the different portions of the canal and the tympanic membrane, while the right hand is left free to use the mirror, or, placing the mirror on the forehead, to use any instruments which may be necessary.

The most frequent change in the external meatus which comes before the surgeon on thus looking into the canal is an accumulation of cerumen, known by its position, form, color, and light reflection. It occurs on account of some hyperæmia of the ear, of which a very common cause is the irritation arising from scratching the meatus with pencils, pins, etc.; but anything which causes an increased flow of blood to the lining membrane of the meatus will cause a greater accumulation of cerumen than normal. It also occurs in those much exposed to the sun and dust, in those who perspire freely, and in the old, in whom the cerumen is denser and stiffer than in the young.

Symptoms.—The subjective symptoms caused by such accumulations are pain, vertigo, confusion of ideas, tinnitus aurium, and deafness, the latter symptom being often characterized by its sudden entrance and departure.

Prognosis.—The prognosis is not so favorable as is generally supposed. If, in the affected ear, a vibrating tuning-fork placed on one of the incisors or on the middle line of the vertex is not heard better than, or so well as, in the non-affected, you may expect some complication, and the mere removal of the cerumen will not probably be followed by much beneficial result to the deafness. Toynbee gives, as the results of his removal of accumulations of cerumen from the meatus causing deafness, a table of 165 cases, of which 60 were cured, 43 were improved, and the remaining 62 were "either but slightly or not at all improved." Mr. Hinton gives one in six as his proportions of recovery in the same. It will thus be seen that in a large proportion of cases of accumulation of cerumen in the external auditory meatus there is a complication present which does not give way on the removal of the cerumen and which clouds the prognosis considerably.

Treatment.—If you can easily lay hold of the accumulation by means of the forceps without risk of pushing it against the membrane and without causing pain, it is well to remove it in that way, especially if you are removing it for the purpose of obtaining a view of the parts behind which you wish to examine on account of some affection present, as, should there be some abnormality of the parts behind, the passage of a strong current of water might prejudice them. But should it not be practicable to remove the accumulation by the forceps without causing irritation, the syringe must be used in the manner described in treating of foreign bodies in the meatus.

A lessening of the secretion is sometimes seen in acute affections of the middle ear and in nervous deafness, but before making your diagnosis in such, inquiry of the patient as to what he has done to the ear before coming to you is useful in eliciting a good reason for the condition found. The use of some slight emollient and attention to the primary cause, if any such is detected, comprise the treatment.

Foreign Bodies.

In no department of surgery is the aphorism that "blind zeal only hurts" more necessary to be remembered than in that relating to foreign bodies in the ear. The form of the canal is so peculiar, being that of a spiral turning anteriorly inward and downward and having expansions at either extremity, and the forms of the foreign bodies which enter or are placed in the meatus are so varied, that the efforts to remove them by any other means than a current of water must be used only where the practitioner is guided by an accurate knowledge of the anatomy of the external meatus if damage to the delicate structures which limit the inner end of the meatus is to be avoided. So common

are forcible attempts to extract by those unaccustomed to meet such cases that it is exceptional that a case is seen by the surgeon before such efforts have been made as have caused a certain amount of inflammation of the canal and its consequent lessening in calibre. In such, where the calibre has been rendered too narrow to admit of the passage of the foreign body without considerable force, the first indication is to allay the inflammation by rest, leeches, and fomentations. The exudation having been absorbed and the canal having nearly or wholly resumed its normal size, the surgeon ought to determine whether there is a foreign body present, and, if possible, its size, form, and position: for cases continually occur in which a patient suffering from chronic disease of the middle ear has the feeling of a foreign body being present, while others are either the subjects of delusion from other causes or are attempting to delude you. This information is obtained by means of the usual mirror, speculum, and probe, by the last of which you can determine if the body is hard or soft or moves easily.

Treatment.—If the last is the case, you may by inclining the head to the side of the ear affected shake it out, or by laying the one hand on the ear a sharp percussion on the hand so placed may remove it. But the persevering use of an injection of lukewarm water from a four- or five-ounce syringe, the point of the nozzle of which has a calibre of from one to two millimètres, is the method which ought to be used above all others, which carries with it the least danger, and is by far the most successful. A bowl being held by the patient so that the rim is pressed against the skin close under the lobule of the ear, the surgeon draws the auricle upward and backward so as to straighten the external meatus, and, the nozzle being passed slightly within the external opening and pressed against the upper wall, a moderately forcible current is made to pass along the upper wall, sweep across the membrana tympani, and by it is directed outward, in which latter course it meets with the foreign body, and, carrying it with it, forces it along the lower wall of the canal and out at the external opening. It may be necessary so to change the position of the patient's head as to give the stream a different direction, according to the position of the foreign body in the canal, the endeavor being always to pass the inward current beyond the body, which ought to be influenced only by the outward rush. Should the body be impacted, it may be necessary to loosen it by the probe before you can remove it by the syringe: but the first injections generally suffice to do this. This failing, which is extremely rare, and the body being soft, you may pass a hook into it from the side and so extract it: or should it be too large for this, you may, having fixed it with the hook so as to prevent it passing farther in by your manipulations, pull pieces out of it by means of small kneed forceps and so reduce its bulk sufficiently to extract by the hook. When the body is hard and so formed that the current cannot have much influence upon it and a hold by forceps or hook cannot be obtained, Lowenberg's method of bringing the point of a camel's-hair pencil armed with joiner's glue or other glutinous material into contact with the body, allowing the viscous substance to harden, and thus binding the pencil and the foreign body together and so extracting them, is sometimes useful. Many other instruments have been proposed to remove foreign bodies, most of which are not worthy of a place in the surgeon's armamentarium: but mention must be made of Wilde's wire snare, which may be found very useful and has the advantage of being very safe, and Mr. Durham's ear forceps, which allows of the passage of the instrument through a narrow speculum—a very great desideratum.

Fig. 130.

Syringing Ear.

It may happen that none of the above-mentioned means will enable you to extract the body, and yet the symptoms of pressure on the nervous structures—giddiness, confusion, delirium, etc.—are so urgent that removal is imperative. In such you may be compelled to place the patient under chloroform, enter the meatus by loosening the auricle from its superior attachments or through the mastoid process, and so reach the offending body and extract. But resort to such serious measures will only be called for by the most pressing symptoms, and then probably in cases where violent unsuccessful efforts to extract have been made, *as the mere presence of a foreign body in the external meatus rarely causes much pain or annoyance.*

Modes of Softening Foreign Bodies.—Before attempting to remove certain

bodies it is necessary to place them in a condition favorable to their removal or to allay the unbearable irritation caused by some of them. For example, a ball of cerumen may be so hard that no instrument will pierce it sufficiently to give the surgeon sufficient purchase upon it to extract it, or it may be too large to pass the isthmus of the external meatus without the use of undue force. In such you are compelled to soften it by repeated soakings in hot water or a solution of glycerine or some alkaline solution before endeavoring to break it up. Again, when some small animal has passed into the ear and its movements are causing great annoyance by irritating the excessively sensitive tympanic membrane, it is necessary to introduce tobacco-smoke or water, or a little spirit and water, or oil, to kill it, and at once allay the irritation before attempts at removal are undertaken.

Maggots are sometimes found in the external meatus and tympanic cavity, especially in cases of otorrhœa, and are generally difficult to remove. Should the membrane not be perforated, the syringe will suffice; but, as in the cases in which they are mostly found the membrane is perforated, the forceps is found more effectual. To allay the pain generally occasioned by their presence, the injection of ten drops three or four times daily of a lukewarm solution of a grain of acetate of lead and a grain of acetate of morphia in an ounce of water will be found of service. Various kinds of aspergilli are met with, especially in climates warmer than that of England; but even in England they are more common than is generally believed, judging from the cases reported in the medical journals as rarities and worthy of notice. The appearance on examining the meatus with the speculum is as if fine meal had been blown into the ear, or as if "coal-dust had been blown on to white sand." The true diagnosis can be made certain by the microscope only. The parasiticides proposed are many, but warm water often used or a mixture of spirit and water will suffice in all cases.

Should it be found, after the removal of any foreign body, that the tympanic membrane has changed its position and does not of itself recover its normal situation, the air-bag or catheter or the vacuum speculum may be of benefit in assisting you to replace it.

A piece of wadding should be lightly inserted in the meatus after the removal of the foreign body and kept there for some hours, so as to protect the irritated parts from cold, strong noises, etc.

It ought to be remembered that foreign bodies in the ear may cause many reflex actions, such as tickling in the throat, giddiness, pain and heaviness in the head, vomiting, cough and expectoration, sneezing, anæsthesia of side, epilepsy, etc.

Furuncles of the external meatus originate generally in one of the hair follicles or in one of the ceruminous glands. They occur mostly as the symptom of some constitutional affection, in which case they are associated with boils on other parts, or of some deeper local chronic inflammatory lesion, and are considered in such as a favorable sign. The long-continued use of astringent lotions, especially of alum solutions, seems to place the meatus in a condition favorable to their formation, if it be not the actual cause in some cases. The symptoms they occasion are great throbbing and pain, consequent on the unyielding condition of the skin and connective tissue of the external meatus to the pressure from the accumulating pus, fever (especially during the evening), sometimes tinnitus, a feeling of tension in the ear, and more or less deafness, according to the position and extent of the inflammation. They occur at all ages and in all constitutions, but middle age obtains by far the majority of cases. The prognosis is favorable, though you may be unable to check the formation of new crops, which go on for months, even in the most robust people.

TREATMENT.—The treatment is conducted either with a view to arrest the development of the abscess, or, the formation being complete, to give the pus free exit. The former may be brought about by painting the swelling with a strong solution of nitrate of silver (℥ss–℥j to ℥j of water) or a solution of sulphate of zinc of the same strength. The latter is best accomplished by a small narrow knife—so narrow in the blade and handle that it does not exclude your view of the part while making a free incision through the boil. After making the incision I found it useful to apply a vacuum speculum (Siegle's; see article on "Affections of the Membrana Tympani") to the meatus and by suction empty the abscess as much as possible of pus and at the same time obtain a free flow of blood from the wound. The application of moist heat afterward by frequently filling the ear with warm water, and laying for half an hour or so a cataplasm over the whole ear so filled, of leeches in front of the tragus if there is much pain, or of a plug of cotton which has been saturated with glycerine (Fisher), changed twice daily, for the same purpose, and the judicious use of purgatives, result in a favorable termina-

tion to the particular boil in question; but the constitutional treatment must follow, to prevent, if possible, the development of others. As a local preventive Mr. Hinton considered that the application to the meatus of red or white precipitate ointment was of service.

Narrowing of the meatus in the cartilaginous portion occurs not unfrequently in the aged, on account of the tense tissue bundles of the posterior and upper walls having become loosened and sunk forward against the anterior wall. This narrowing seldom leads to complete closure, and therefore does not influence the hearing-power to any extent; but its presence prevents the normal exit of the cerumen, and so tends to the formation of cerumen balls beyond the narrowed part of the meatus, and their results. Other narrowings besides those which are congenital arise from thickening of the skin after frequent attacks of inflammation of the meatus, after furuncle and other tumors, eczema, and the long use of astringent lotions or ointments. Except in the case of tumors, you may widen the canal by the use of the *laminaria digitata*, or sponge dilators, sufficiently to form your diagnosis and apply remedies.

Treatment.—Treat any affection of the tympanic cavity which may be present. Keep the canal clear of cerumen and epidermis by injections of lukewarm water or the passage of a dry camel's-hair pencil, and by the use of small ivory bougies gradually increased in size, so that the amount of pressure may be kept up, promote absorption.

Exostoses of the meatus are found in individuals of the gouty, rheumatic, and syphilitic diatheses, though their connection with this last diathesis is not well established. They are certainly frequent in the meatus of good livers, who are likely to have their mucous membranes frequently congested. On looking into the meatus an elevation is seen, generally about the middle third, the skin over which is reddened and moist and pressure on which by the sound causes pain.

Treatment.—The treatment is not satisfactory unless the exostosis has a pedicle, in which case it may be broken off. In other cases, having paid attention to any affection causing congestion of the mucous membrane of the tympanic cavity, the application of iodine to the growth itself, and behind the ear, so as to keep up a slight counter-irritation for a lengthened time, and the exhibition of it internally, offer the best hopes of resolution. Should, however, the exostosis prevent the exit of pus from the parts internal to it, the formation of a channel by a hammer and chisel, trephine, dentist's drill, or electrolysis, and the maintaining of it by tents, may be imperative for the purpose of keeping the parts clean and the application of medicaments to the parts beyond.

Hyperostosis of the bony meatus is seen after a chronic otorrhœa, and generally extends through the whole of the bony canal. It is caused by inflammation of the periosteum, which results in a well-developed bony formation. The skin along the narrowed portion of the canal is more or less congested. The treatment is that of exostosis.

Molluscous tumors of the meatus consist of accumulated laminæ of epidermis and sebaceous matter enveloped in a thick membrane. Though thus composed of comparatively innocuous material, they have the power of causing absorption of the bone lying in contact with it, passing through it by a clean-cut aperture without affecting the bony sides of the canal thus caused, and so pursuing their course pass to and press on the parts beyond, causing symptoms varying according to the parts implicated. The diagnosis of this molluscous tumor from exostosis is made by pressing a probe on the skin over the tumor and noting the hardness of the enlargement. Laying open the tumor, washing out the accumulated epidermis by the syringe, and withdrawing by the forceps the lining membrane is the treatment recommended.

Syphilitic affections of the meatus occur as fissures and ulcerations near the orifice, condylomata, and exostoses. The ulcerations exhibit the usual punched-out-irregular contour and discharging surface. The treatment is the usual—general and local.

Inflammation of the external auditory meatus, or otitis externa, is an inflammatory affection of the cutaneous tissues of that canal, involving more or less, according to the violence of the attack, the periosteum of the osseous part of the canal and the membrana tympani.

Symptoms.—The patient complains of a continual itching sensation, with a feeling of heat and dryness, in the canal, which compels him to pass any suitable instrument which may be at hand into the meatus for the purpose of scratching the part implicated. This irritation may pass off without forcing the patient to seek advice, or it may pass on to one of pain shooting over all the affected side of the head, increased by every motion of

the head or by mastication, and accompanied by a feeling of fulness in the ear, by fever and deafness. After this congested state has lasted for two or three days, that of exudation enters—at first as a bright watery discharge, which gradually assumes a mucous character; and this in its turn gives way to a yellow purulent appearance. The pain, which till now has been usually severe, subsides when the purulent discharge shows itself, or soon afterward, and the patient feels lighter and freer of the sensation of "numbness" or "fulness" of which he before complained. A favorable termination without any treatment may now take place, though more frequently the affection becomes chronic and the patient suffers from recurrent attacks on being affected by any exciting cause.

Appearances.—In examining the ear it is not always easy to arrive at a satisfactory diagnosis, on account of the painful swelling of the canal, which is particularly sensitive about the middle third and resents the introduction of a speculum. When you are able to introduce the speculum sufficiently well to see the inner part of the meatus, you may find a mass of moist or macerated white epidermal lamellæ obstructing your view of the membrane, necessitating the careful use of the forceps or injection of warm water for their removal. Having removed these and obtained a view of the membrana tympani, you find, in those cases in which that membrane is affected (and it is rare that you are consulted before it is so), the vessels of the membrane increased in number and size and fully injected; or if the case has reached a further stage, the single vessels are no longer visible and the whole has a resemblance to a red blennorrhœic conjunctiva. The natural angle formed by the skin of the external meatus and its continuation with the dermoid layer of the membrana tympani is obliterated, or nearly so, by the pressure of the exudation inside the cutaneous tissues. But the exudation may be so great and may have so narrowed the canal of the meatus that only a small part of the membrane can be seen, its appearance depending upon the part seen and the stage of the affection. The acute stage being neglected, it passes gradually into the chronic form, in which there is generally little swelling of the meatus, possibly here and there slightly macerated or pus-covered spots, which bleed easily on being acted on by the speculum, or brown, badly-smelling crusts standing upon half-dried secretions. The amount of secretions vary from a moisture discernible at the external opening of the meatus to three or four ounces daily of a high-smelling yellow discharge, and changes by the seasons and other influences. The alarming results of the affection are dependent upon the continuance of this otorrhœa, which, if of long standing, may cause opacity or thickening of the membrane, polypi, maceration of the surrounding tissues, with ulceration of the membrane and its consequences, inflammatory and purulent processes in the dura mater and its sinuses. These latter are especially frequent in children, in whom the conditions for the transmission of such processes are easy.

The diagnosis of this diffuse inflammation of the meatus from that of furuncle of the meatus is made by means of a speculum in which a small mirror placed at the end of the instrument may be revolved, so as to give the observer a reflected image of the different parts of the meatus in succession, or by means of Blake's small mirrors; or should neither of these be admissible, by the contraction of the meatus, by the moist appearance of the dermoid covering of the membrana tympani in furuncle, the same layer in otitis externa having the appearance of the rest of the meatus.

Causes.—The causes of inflammation are the passing of any acute or chronic exanthemata to the meatus, irritation or injuries to the ear, as by the application of heat or spirits to the meatus, the prolonged use of injections, the pressure of foreign bodies, the passage of cold currents of air or water, the non-drying of the ear and hair round it thoroughly after washing, the presence of fungi, and, in short, anything causing a congestion and irritation of the lining membranes of the meatus.

The affection may run its course in ten or fourteen days if the purulent stage has not been reached, but, that stage having supervened, it lasts from five to eight weeks generally.

Prognosis.—The prognosis in a usual primary case under treatment is favorable, but relapses are common. The form following an acute exanthem is very different, as, should the middle ear inflammatory process be well developed and the membrane much affected, the chances of saving an entire membrane are lessened.

Treatment.—The treatment is etiological. If there are foreign bodies present, their removal demands your first attention; and after this the prevention of any purulent accumulation and the use of frequent injections of warm water are the chief treatment. Should the swelling be great, scarification of the meatus or an incision and abstraction of blood by the vacuum speculum seems to be of more use than any other means in causing

a speedy subsidence of the thickened membranes, which you may also assist by keeping up a pressure on the circumference of the canal by charpie gently pressed into the meatus, being careful that the charpie is frequently renewed and the meatus cleared of discharge. What is called "Wilde's incision," from its having been first brought into notice by Sir William Wilde, is a favorite means of remedy with some, and in the relief of pain or as a means of giving exit to any exudation which may have passed toward the mastoid process is very useful. It consists in making an incision down to the bone over the mastoid process at a distance of from half to three-quarters of an inch from the auricle, carefully avoiding, if possible, severing the posterior auricular artery. The application of leeches in front of the tragus (should the patient be too timid to allow of the abstraction of blood by incision or scarification) is advisable where the pain is severe. During the painful stage no strong astringent lotions must be used, those of a sedative nature being preferred, as morphia in the strength of gr. j to aq. dest. ℥ss, or sulphate of of atropine gr. ij. to ℥j. This stage being passed, the use of the customary astringent lotions—alum, sulphate of copper, sulphate of zinc, in solutions of from one to four grains to the ounce, or nitrate of silver of from ten to twenty grains to the ounce—are, with attention to any complication of the middle-ear apparatus and to the diathesis present, sufficient to ensure a favorable course. Should the affection have assumed the chronic form, stronger solutions of the astringents mentioned ought to be employed; and the keeping up of a counter-irritation behind the mastoid by tincture of iodine, cantharides ointment, or other irritant, will be found serviceable.

Polypus.

Aural polypi generally show themselves during a chronic purulent discharge from the tympanic cavity or external meatus, and are not only caused by such a discharge, but are themselves a means of increasing it by furnishing an additional secreting surface, and, by preventing the exit of the discharge, keeping the parts pressed upon by the pus in an unhealthy irritable condition. They are of different forms and appearances, being of a lively red, rich in blood, soft, and easily bled by touching, or firm and solid with a glancing surface, grape-like or ragged, so small that their presence can be determined only by a careful inspection of the deeper parts or so large that they protrude from the meatus. Their positions are as varied as their forms, as they arise from any part of the meatus or tympanic cavity or membrane, the different authorities not being agreed as to which are the most frequent sites. Happily, their diagnosis and treatment are the same, the former being their capability of displacement by the sound, and the latter their removal either by caustics, astringents, the forceps, scissors, knife, hooks, the galvanic cautery, or Wilde's snare.

Treatment.—If the polypus is sensitive, which is not usually the case, and the patient will not suffer the removal by instruments, the application of undiluted liquor plumbi or alum or tannin powder regularly for a time, care being taken that each new application meets with a clean surface, will suffice; but the treatment above all others is the immediate removal by instruments as far as possible and the application thereafter to the root of some caustic, such as acetic, nitric, or chromic acid, by means of a glass rod or piece of wood. The instruments employed for the purpose are numerous, those which I find most useful being Wilde's snare, Durham's forceps, and Hinton's forceps. Wilde's snare is especially valuable, as by its means you are capable of reducing a polypus to a considerable extent without endangering any of the structures near it, while the others have the advantage of easier adaptation to an excrescence which is difficult of reaching. Should the polypus be very small or so situated that you cannot use a cutting or tearing instrument, the application of a thin layer of nitrate of silver, obtained by heating a crystal of the caustic over the flame of a spirit-lamp and placing a probe or piece of stout silver wire against the heated crystal, will be found useful in cauterizing it, and at the same time limiting the application to the desired spot, which is not so easy when solutions are employed. After the removal of the polypus, the disease of which the growth was only a symptom must be attended to.

Affections of the Middle Ear.

Injuries to the Membrana Tympani.—Rupture of a healthy tympanic membrane is usually caused by the introduction of some sharp instrument through the external meatus, the efforts to extract some foreign body from that canal, or by a sudden

concussion over the auricle, as by a blow from the hand, the unexpected explosion of artillery, or such like. The diagnosis of rupture in such is easily ascertained, but medico-legal questions sometimes arise in which it is necessary to determine whether a rupture was caused by a blow on the ear or was present before the blow was given, or whether the membrane was in such an unhealthy condition that it would be easily injured. The rupture of a healthy membrane caused by a blow is usually a long gaping tear—the gaping depending on the action of the radiating fibres of the middle layer—the edges of which have a coating of blood upon them. The rest of the membrane is healthy, free of thickening, opacities, cretaceous or other deposits, though possibly hyperæmic. On passing a current of air through the Eustachian you hear a continuous broad soft sound, unlike the broken hiss from the perforation of a diseased membrane, unless some time has elapsed since the rupture was made, in which case infiltration and exudation may have occurred, giving the appearances and sounds of a diseased membrane.

Prognosis.—The prognosis, unless pus has formed to some extent and deafness to a considerable extent is present, is very favorable, and the perforation will be quickly healed without further treatment than keeping the membrane protected from cold. Should, however, considerable deafness and tinnitus have occurred from a blow, either with or without rupture of the membrane, the prognosis is unfavorable, as probably the stapes has been driven into the labyrinth, tearing the nerve fibres and possibly remaining fixed there; and you must keep the patient a lengthened time under observation before giving any opinion of what the results will be.

Inflammation of the membrana tympani, or myringitis, is probably always associated with some affection of the internal or external parts contiguous to it. The diagnosis and treatment will be found in the description of inflammation of the external meatus.

In examining the membrana tympani the points to be noted are its color, transparency, lustre, light cone, inclination, curvature, entirety, tension, whether adhesions are present or not, and the position of the malleus, especially of its short process. For a full description of these we must refer the reader to Politzer's *Beleuchtungsbilder des Trommelfills im Gesunden und Kranken Zustande* (Wien, 1865), but the following short note of changes seen in the most common affections in which it is implicated may be found useful in diagnosis. In acute inflammation the membrane is smooth and glistening, and more or less red according to the amount of hyperæmia present. When the mucous layer is hypertrophied, and accordingly a greater amount of secretion present than in the normal state, the membrane is less shining than natural and has a whitish-gray parchment look. If there is a considerable accumulation of mucus which has lain in contact with the membrane for some time, it assumes a sodden appearance, as if the parchment had been steeped in fluid. The changes of inclination and curvature of the membrane depend upon closure of the Eustachian tube, adhesions to the other walls of the cavity, accumulations of pus, mucus, or tumors, internal or external to the cavity, and perforations or thinnings of the membrane, and can only be diagnosed by seeing numerous cases at an aural clinique. The fact that usually only one eye is brought to bear at a time on the membrane makes it difficult for the observer to judge of displacement, protrusions, or any changes in which the judging of distance is required till he has accustomed himself to the use of one eye only.

Fig. 131.

Appearance of Membrana Tympani, showing the relation of Parts to each other. (Right ear.)

Chronic perforation of the membrana tympani is one of the most common affections of the ear on which you will be consulted. The diagnosis of the affection is easy, either by the speculum, by asking the patient to drive a current of air by a forcible expiration through the Eustachian tubes, the nostrils and lips being held firmly together—this method being called Valsalva's method—by passing a current of air from Politzer's bag, as described under malformations of the external ear, or by passing the Eustachian catheter and forcing a current of air from the mouth or from an india-rubber bag through the catheter. By these three last methods you will obtain, the Eustachian tubes being open, a sound more or less of a hissing character, depending upon the rush of a column of air through a small orifice. The usual causes of the perforation of the membrane, apart from those of a traumatic origin, are scarlet fever, measles, tuberculosis, and any greatly debilitating affection in which the mucous membranes are affected.

Prognosis.—The prognosis is regulated greatly by the dyscrasia present, but it ought always to be remembered that a perforation may heal without leaving any discernible

pathological changes and without in the slightest recognizable degree lessening the power of hearing. The hopes for such a happy result are the greater the shorter the acute attack which has caused the perforation, while it is rare after a chronic affection accompanied by otorrhœa; but no opinion ought to be hazarded till you have carefully washed out the ear and seen the extent of the perforation and losses which have already resulted therefrom. The process of healing is known by a gradual diminution of the secretion and of the perforation, the cicatrix being formed by the dermoid and mucous layers, but of a much more delicate structure than the natural layers and not separable into laminæ. The hopes of cicatrization are at an end for the time when the edges of the perforation become cicatrized and a gap still remains, but a new impetus may be given to the regeneration by any future affection which causes a hyperæmia in the part and a softening of the cicatricial edges of the perforation.

Treatment.—In the treatment of a perforation the rule is to close it if possible, on account of the exposure caused by the perforation of the tender mucous membrane of the tympanic cavity to cold air or water, dust, and other foreign bodies. These by their irritation may cause a purulent discharge, and that, being once present, may lead to results of the most disastrous nature. But if the perforation have existed some time and be of a considerable extent, the question arises whether the closing of the perforation will not impair the patient's hearing-power; and before doing anything to close such it is advisable to temporarily close the gap by a drop of glycerine or other thick fluid and note the effects. Should the result be to lessen the hearing-power to any considerable extent, you must carefully consider the probabilities before determining upon your action. While the affection is still in the acute stage, the keeping of the parts clean by gentle injections and the use of some slight astringents, for the purpose of reducing the secretion of the membrane and bringing it into a more normal condition, are all that are required, with the use of a little wadding in the ear when the patient goes out, unless the weather is very mild, when the latter may be dispensed with. Should discharge be present which by some means has become thickened, and by its presence closes or tends to close the Eustachian tube, Politzer's operation ought to be done now and again; and if this is not sufficient of itself, the softening of such an accumulation by an alkaline solution, as bicarbonate of soda ʒss–ʒj to an ounce of water, and then the Politzeration, will suffice to remove it. Should you determine to try to close a large perforation, you carefully and gently stimulate the edges of the perforation by the application to them of nitrate of silver or other irritant, either in solution or by touching the moistened edges with a thin layer of the crystals placed on a probe, as mentioned in the treatment of granulations, or by abrading the edges with a knife, conical file, or plug of wadding turned in the perforation. But if you fail to close it by the growth of new cicatricial tissue, and yet believe that its closure would improve, or at least not impair, the hearing capability, you may resort to the artificial drum, the success of which in some cases is very great. Numerous modifications of artificial drums have been proposed, but the most simple, the most easily applied, and one that is as successful as any other is a piece of cotton-wadding moistened in water or some antiseptic solution and applied over the perforation and lapping considerably over the edges. The difficulty of its use is its first adaptation; but if once applied successfully, the patient can adapt it in future for himself more truly and quickly than his medical attendant. The conclusion as to whether it will be of benefit or not must only be arrived at after several attempts have been made, changing the point of pressure and adapting it more closely to the remnant of natural membrane at different points at each attempt. When it has been used for some time with success, the patient feels it very inconvenient to be without it. If found of service, it ought not to be worn above an hour or two at a time for some days, gradually increasing the duration of its application, but always removing it at night, and the patient should be directed to attend to the most perfect cleanliness at each renewal of the wadding. How the artificial membrane acts is still a matter of doubt. It is considered that it is a support to the ossicles and membranes, and this is probably its action in the majority of cases. From observations at the different positions in which it increases the hearing-power, I think it may have also a resonating action.

Artificial Perforation of the Tympanic Membrane.—Having spoken of the means of closing a perforation, it is convenient here to speak of artificial perforation of the membrane. The operation is recommended in cases of accumulations of pus or mucus within the tympanic cavity, of impassable stricture of the Eustachian, of thickening of the membrane, of adhesions of the membrane to the tympanic walls, in case of tinnitus, and in cases where no benefit is derived after prolonged use of other curative

means and the diagnosis is not clear, but the acoustic is not much affected. That benefit may be derived in all such cases cannot be denied, but unhappily we are not yet in a position to say that perforation will benefit this or that case, except in cases of accumulation. The point of operation is determined in cases of accumulation by the point of the membrane at which bulging is present, while in other cases a spot behind the manubrium is usually chosen. Bringing the membrane well into view by the usual method, the operation is made by means of one of the numerous instruments which have been proposed for the purpose. If it is merely as an experimental proceeding to determine whether an opening will be of benefit to the hearing, or for the purpose of allowing the exit of pus or mucus, a small plain double-edged scalpel is all that is required. Having made the opening sufficiently large, you remove all impediments to the passage of sound by causing an air douche to be passed through the cavity by one of the usual methods, having, if necessary, previously softened any accumulations. It being thus empirically determined that a permanent opening in the membrane would be desirable, you attempt to keep the opening from closing by a bougie or Politzer's eyelet, by making the perforation by the galvano-cautery, by removing a part of the malleus with a portion of the membrane, by the constant use of the air douche, by repeated removals of the cicatricial membrane, by digestion with pepsine, acids, etc. But as yet no method has been proposed which acts with certainty of success.

Catarrh of the Middle Ear.—The ordinary *affections of the middle ear* which the general practitioner will be called upon to treat are included under the title of "catarrhal affections," and may be of an acute or chronic character. The principal objective symptoms of acute catarrh are a hyperæmic swelling of the mucous membrane, with an increased secretion therefrom, the pharyngeal mucous membrane near the orifice of the Eustachian tube leading to the affected ear being nearly always implicated. This state of the mucous membrane gives to the observer who passes a current of air through the Eustachian tube and listens by means of an otoscope, one end of which is placed in the meatus of the patient and the other in his own, sounds ranging from a harsh dry sound, like that caused by distending a dry bladder, to a mucous râle. The tympanic membrane varies in appearance, according to the stage of the affection, from that of a glancing polished copper plate to that of a dull wet bladder from which all bright reflex has gone, corresponding to the dry and infiltrated states of the tissues. A more or less obliteration of the malleus may be present, depending upon the passage of the exudation between the layers of the membrane. A bulging of the membrane will be observed should an accumulation of fluid have taken place to a considerable extent. The chief subjective symptoms are a pain in the depth of the ear, which is increased by every motion of the parts, such as by coughing or swallowing, an impairment of hearing, a feeling of heaviness, fulness, or pressure in the ear—often described as "a drop of water in the ear"—tinnitus of various characters, as singing, knocking, or surging, the position of which, whether outside or inside the head, the patient cannot always tell, giddiness, confusion of thought, and other symptoms of pressure. The subacute form is merely a combination of the same symptoms in a milder degree. If the case is properly attended to while in the acute stage, no graver disturbances of the organism ought to arise; but it must always be remembered that, the tendency of the affection being to thickening and swelling of the membranes implicated, adhesions and solderings are apt to take place between the closely-situated delicate structures of the tympanic cavity. The general position of such adhesions is between the manubrium and promontory, the tympanic membrane and incus or stapes, the tendon of the tensor tympani and stapes, and especially often in the niches of the two fenestræ, binding the walls together or to the stapes.

But should the acute stage be neglected, the acute passes into the chronic form, generally, like the acute, implicating both tube and cavity. It may, however, be localized, and consist in repeated swellings with gradual condensations and thickenings of the mucous membrane, which becomes gradually less elastic, and by proliferation form bands in the cavity. These by their physical qualities as well as by their interference with the swinging faculty of the sound-conducting apparatus materially interfere with the hearing capabilities. This chronic form, once established, is most obstinate to treatment and leads to increase of the deafness, which depends more on the locality of the changes than on their extent. It also causes an increase of the symptoms of pressure, the tinnitus possibly becoming so harassing that persons have been known to have committed suicide to escape from it, and often causing such depression by the effects of the vertigo and vomiting which it occasions that an inclination to resort to intoxicating fluids is thereby aroused.

Prognosis.—The prognosis is generally favorable, but the treatment is prolonged over such an extent of time that the patient frequently ceases to attend before restoration is accomplished, or aid is not sought in time to prevent changes which, having once occurred, cannot be undone. In these cases we must endeavor to stay the course of the disease; which, if left to itself, will certainly lead to total deafness. The older the patient the more chronic the affection; and the greater the changes formed in the tympanic cavity, the less hope is there of a good result. If the tinnitus is continuous and has been present for some time, the prognosis is unfavorable, even although under treatment the hearing-power is improved; while if nearly total obliteration of the cavity has occurred, especially if chalky deposits are present on the tympanic membrane, a favorable prognosis is almost negatived.

Treatment.—The treatment, besides the constitutional and hygienic, consists in local blood-letting while the pain and hyperæmia are present, the application of the air douche, the injection of medicaments to the Eustachian tube and tympanic cavity, the treatment of any naso-pharyngeal affection which may be present, and the performance of different operations on the sound-conducting apparatus. Two methods of passing a current of air into the tympanic cavity through the Eustachian tube have been already described (p. 322). The passage of the Eustachian catheter, used either for the conveyance of air, fluids, or vapors or for the better guidance into and through the tube of bougies, elastic catheters, or instruments for electrical purposes, is by no means so difficult as is generally believed. The silver catheter with an obtuse angle of from 110° to 120° is, I find, the most generally useful in the hands of those accustomed to pass it. The caoutchouc ones are apt to break after being used some time, and do not convey to the operator such accurate knowledge of the position of the beak in relation to the structures over which it passes as those composed of metal, although the caoutchouc are less likely to make a false passage in the hands of an inexperienced operator. The patient ought to be placed with the external openings of the nares horizontal and opposite to the right shoulder of the operator, who, tilting the point of the nose upward by the fingers of the left hand, discloses the cavity of the nares more fully, upon the floor of one of which he places the beak of the catheter. Keeping the beak on the floor, he passes it through the cavity and onward across the pharyngeal space till it comes against the posterior pharyngeal wall, which in its normal condition gives him much the same feeling of resistance as he receives on pressing the catheter against the tense open palm of the hand. Drawing the catheter toward him, and at the same time elevating the end which he holds in his hand, he brings the concave curvature of the opposite end against the posterior edge of the nasal floor, and then, turning the beak outward and upward, keeping it at the same time against the external lateral wall of the pharynx, he will feel it make a slight dip into the pharyngeal opening of the Eustachian tube.

The above method is the one usually adopted, but there is that proposed by Bonnefont, which consists in turning the beak of the catheter from the posterior pharyngeal wall outward into Müller's depression and drawing it then toward you till you feel that it has passed over a swelling and then fallen into a depression; or Lowenberg's, consisting of turning the catheter beak inward after reaching the post-pharyngeal wall, drawing it toward you till the curve catches on the posterior edge of the nasal septum, and then revolving it upward or downward toward the lateral pharyngeal wall, when it will probably pass into the tube. If there is a difficulty in passing the catheter through the nasal cavity, it is generally most easily overcome by keeping the beak toward the external wall and passing along it. But should you fail in passing it through the nostril corresponding to the Eustachian tube into which you desire to introduce it, by using a catheter with a longer curve you can reach the mouth of the Eustachian tube from the other nostril, or you may pass it into the tube from the mouth. You know that the nozzle has passed well into the mouth of the tube by the position of the catheter not being disturbed when the patient speaks or swallows, by the fact that the nozzle will not pass further upward, and especially by the fact that on blowing air into the catheter, either by mouth or india-rubber bag, you recognize its passage into the tympanic cavity of the patient by having placed a tube of communication from his meatus to your own. In children the outward turn of the catheter is usually more limited in extent than in the adult, in whom it is generally from a fourth to three-eighths; but a latitude must be allowed, as the formation of the part varies. In a new patient, if you wish to pass the catheter into the Eustachian tube, it is advisable to try the right side first, as it will be found usually easier to pass on that side, on account of the septum gently inclining toward the left. The mistake generally made is that the catheter is not brought sufficiently forward after

having reached the posterior pharyngeal wall, so that the beak falls into the depression posterior to the opening of the tube. But this may be easily averted by attending to the directions above given as to feeling pressure of the curve on the back of the septum or soft palate before turning the beak outward.

Dr. Weber-Liel of Berlin has lately introduced a small elastic catheter for the purpose of securing the passage of injections directly into, or the removal of accumulations from, the tympanic cavity. This is passed through the usual silver catheter as a director to the tube, and having thus, on its exit from the silver catheter, obtained a position in the tube, it is passed on with a little care through the tube and into the tympanic cavity.

The injections passed through the catheter consist of preparations of potass, ammonia, iodine, mercury, silver, zinc, atropine, chloral, etc., in solution, care being taken that the fluid is lukewarm at the time of entrance.

The following solutions may be found useful: Sulphate of zinc in varying strengths from one to ten grains, of muriate of ammonia five to twenty grains, of iodide of potassium ten to sixty grains, iodine one to five grains, chlorate of soda five grains, to the ounce of distilled water. Before using them always see that the tube is pervious and cleared of mucus or other removable obstruction to their entrance. They are probably most useful when employed every second or third day for from three to eight weeks, after which an interval of a month or more of rest is advisable before continuing their application. The injections through the elastic catheter, passing directly to the tympanic cavity, ought to be much weaker.

Should objections be made to the passing of the catheter, so that you cannot use it in passing fluids or vapors to the ear, the instruction of the patient in doing Valsalva's method of inflating the tympanum, by which he may drive steam impregnated with a little iodine and acetic ether, will serve the purpose. The method of doing so is as follows: Having placed from ten to twenty drops of a solution consisting of equal parts of tincture of iodine and acetic ether in a pint of hot water, the patient inhales a mouthful of the steam, and, having closed the nostrils with the fingers, makes a violent expiration, keeping the mouth and nostrils firmly closed. The steam by this forcible expiration is driven against the walls of the naso-pharyngeal space and mouth, and, the Eustachian tubes being the only spots for exit, rushes up these and fills the tympanic cavity, a sensation of fulness, and possibly warmth, being felt in the ear by the patient if the operation has succeeded. This ought to be done several times at a sitting, the patient swallowing between each inhalation. But should the Eustachian tubes be not rendered pervious by the force used, as is not unfrequently the case when the mucous membrane is considerably swollen, the catheter must be resorted to, as by the passage of a current from an india-rubber bag directly through the catheter to the tube an obstruction which will not give way to Valsalva's method will be overcome.

The treatment of the naso-pharyngeal space consists in topical application to the mucous membrane of the space of astringents such as alum, tannin, or nitrate of silver. A very useful form is the drawing of a solution of alum up the nostrils, allowing it to pass back into the pharyngeal space, expectorating it, and then blowing the nose violently. When the alum is thought not sufficient for the condition present in the pharynx, a nitrate-of-silver solution of from ℥ss–℥j to the ℥ of water applied to the pharynx, and especially to the membrane round the Eustachian regions, will be found a valuable agent. The patient being seated so that good light is thrown into the mouth, and the tongue being depressed by a tongue spatula or the index finger covered by a stall, he is desired to take a deep inspiration, at which moment the surgeon takes the opportunity to pass the brush, which has been dipped in the solution, to one of the Eustachian regions, and, making a half revolution upward, passes over the whole roof of the space to the Eustachian region of the opposite side. The use of gargles at home between the applications of the caustic is to be recommended.

Professor Gruber and others use what is called the nasal douche by driving from a syringe the nozzle of which fills one nostril, the other being closed by the fingers of the operator, a current of some astringent solution up one nostril and so into the other, the obstruction to its exit from the other nostril by the fingers regulating the force with which it acts on the pharyngeal walls. But it is so difficult to regulate that force with the resistance of the Eustachian tubes that the fluid may pass into the tympanic cavity with such a rush as sometimes to do serious damage, and accordingly I would not advise its being applied by those unaccustomed to its use.

The operations on the tympanic membrane and structures of the cavity are perforation, division of adhesions, and tenotomy of the tensor tympani. The perforation of the

membrane has been spoken of at p. 332. The division of adhesions and of the tensor tympani is made by small curved bistouries or by revolving cutting hooks made for the purpose. Those of Weber-Liel and Gruber will be found most useful. The determination of adhesions, with their exact positions, is best made by using Siègle's pneumatic speculum, by which, on creating a vacuum in the meatus, you are able to note what part of the membrane is bound down and does not fall into the vacuum with the rest of the membrane. It requires a considerably lengthened experience in aural diagnosis to be certain of the necessity for or advantage to be derived from such operations.

Otitis media or purulent catarrh is merely a higher grade of inflammatory mucous discharge, but it has always a much more unfavorable prognosis than simple catarrh. The symptoms are much the same as in simple catarrh, but more violent, being accompanied with severe pain, fever, and nearly always leading to perforation. This, should there be an accumulation of considerable extent in the cavity, is to be desired rather than feared; because, should the membrane not give way, as is apt to be the case in a thickened membrane from chronic catarrh, the pus is apt to find its way through some of the many passages which often exist between the tympanic and cerebral cavities, and so cause meningitis.

Treatment.—The treatment is conducted on the usual principles. Give the pus every opportunity of free exit, either by natural or artificial channels, and thus allay fever and pain and save time and tissue. Leeches, opiates, purgatives, and warm-water injections into the meatus, keeping the Eustachian open so as to have a natural drain, if necessary perforation of the membrane at the point of bulging, and when otorrhœa has occurred regular syringing of the ear with lukewarm water to which an antiseptic or astringent has been added, are what are generally found successful. To make the astringent employed pass into the cavity and through the Eustachian tube, it is useful to fill both canals with the astringent, causing the patient to keep it there till you pass a current of air through the Eustachian, on which the fluid in the external canals will rush into the cavity and Eustachian, or by driving a current of fluid with or without medicaments through the Eustachian tube and tympanic cavity from one side or other. In addition to the local treatment, that of the constitution must be attended to, the residence of the patient in such chronic discharges being of especial importance.

The pus catarrh of children is often most insidious in its progress and may cause great injury before its presence is suspected. Till a discharge appears, probably the ear has not been looked upon as the seat of any disease, on account of the child's inability to localize its pain or tell of its deafness. The screaming of the child when pus has formed is loud and persevering, especially at night, is increased by every movement or concussion of the body, especially by movement of the head, and, above all, by sucking at the breast, which at last becomes so painful that the child refuses to take the breast entirely, preferring to be fed by the spoon.

Treatment before Perforation.—In nearly all the cases of suppuration in the tympanic cavity which come before the surgeon the pus has already made its way through the membrane, and the child is brought to you on account of the discharge from the ear. Should you, however, see the child before the pain is relieved, you may, by the timely use of the remedies mentioned as useful in otitis media and the free opening of any enlargement over the mastoid process, with, if necessary, opening into the mastoid itself if there be indications of pus-accumulation there, prevent the destruction of valuable structures. The great cause of the affection is scarlet fever, though measles and typhoid fever contribute largely to the number of cases.

Treatment after Perforation.—When the acute purulent has become chronic, there is a widespread prejudice amongst both the laity and professional men against the stopping of such a discharge by treatment. This prejudice cannot be too strongly combated, as, though in such chronic cases there are generally present slight deafness and only occasionally pain, we can never be certain that complications arising from the constant otorrhœa, such as polypi, paralysis of the facial, ulceration, caries and its results, will not occur.

Affections of the Labyrinth.—The chief symptoms of this class of cases are great deafness, gradually or suddenly acquired, diagnosed by the patient's inability to hear the vibrating-fork when placed on the bones of the skull, vertigo, tinnitus, with possibly nausea, vomiting, and pain. The conditions causing such affections are believed to be hyperæmia of the labyrinth or hemorrhage into it, inflammation of the labyrinth—which is generally in children considered under the term of "meningitis"—and malignant affections. But affections of the internal ear are much more numerous as secondary

affections resulting from an extension of disease of the middle ear, meningitis, fevers, tumors, aneurism, anæmia, hysteria, childbirth, or syphilis. With the latter, arising from hereditary syphilis, are generally seen the syphilitic physiognomy; and in all the cases which have yet come before me in which the acoustic was considerably impaired, changes in the choroid were invariably found if the media were sufficiently clear to allow of a view of the retina being obtained.

Treatment.—The treatment, should syphilis be the cause, is not entirely hopeless, but if from other causes is almost nil. Strychnia, quinine, morphia, and local remedies have their different advocates. Electricity may be tried, but a sufficient number of carefully recorded cases is still required before an opinion of its value can be given.

Deaf-Mutism.—By far the majority (above three-fourths) of the cases of deaf-mutism arise from congenital affections, the remainder resulting from fevers, teething, hydrocephalus, convulsions, etc. The hereditary influences are undoubted; and when such are present it is often seen combined with retinitis pigmentosa. The pathological conditions found in such are changes in the tympanic cavity with defects in the sound-conveying apparatus, abnormalities in the labyrinth or cerebrum, especially near the fourth ventricle. But the inner ear or cerebrum may have no perceptible changes sufficient to account for such a high degree of deafness as is present. The treatment is the careful cultivation of any remnant of hearing which may be present and the placing of the child in an institution for the education of deaf mutes, where by the careful watching of the lips of the speaker they are able to follow him in conversation, and by a laborious teaching of the positions in which the organs of speech are to be placed in forming the different syllables they are rendered capable of answering.

SURGERY OF THE CIRCULATORY SYSTEM.

CHAPTER X.

WOUNDS OF THE HEART AND ARTERIES—HEMORRHAGE AND ITS TREATMENT.

Wounds of the Heart.

Although it is quite possible for the anterior mediastinum to be traversed from side to side by a foreign body without any important structure being wounded, it is far more common for some severe lesion to be the result, such as a wound of the pericardium, heart, lung, or of the great vessels. A wound of the *pericardium alone* may occur and not prove fatal. Dr. G. Fischer has collected fifty-two reputed cases of this nature, including punctured, incised, gunshot, and lacerated wounds, of which twenty-two recovered. The chief danger of this local injury lies in secondary inflammation of the membrane. From a unique preparation shown by Mr. Morrant Baker in May, 1877, at the Pathological Society, it would seem that an omental or other hernia may take place from the abdominal cavity through the diaphragm into the pericardium by an aperture the result of some antecedent stab.

The operation of "paracentesis pericardii" has been performed with advantage, and generally with the aspirator. The best point for puncture is probably the left fifth intercostal space nearer the rib below than the one above, and about two or two and a quarter inches from the median line of the sternum. Dr. J. Roberts[1] of Philadelphia, has tabulated sixty cases of the operation, of which twenty-four recovered. When pus exists and can be diagnosed, it may be evacuated by an incision in the left intercostal space below the nipple, and the pericardium drained, as proved by the case of Dr. S. West, read at the Roy. Med. and Chir. Society, April, 1883.

Wounds of the heart itself are generally mortal, rare instances only recovering. Death takes place immediately in about one-fourth of the cases, and in the bulk of the remainder after a few days. The symptoms of a wound of the heart are very uncertain, but the most important, says Poland, "is the presence of a *lesion* in the neighborhood of the heart, with *external bleeding*, followed by all the signs of sudden internal hemorrhage." Sudden *collapse* is a very general consequence of the injury; when it comes on some time afterward, it is probably due to secondary hemorrhage from the giving way of the clot in the wounded heart. *Dyspnœa*, according to Fischer's analysis, is not constant; in some cases it is immediate and intense. It seems to be due to compression of the heart by the effusion of blood into the pericardium and pleura. The *pulse* is often unequal, small, and intermitting. *Pain* is uncertain. The position of the external wound is a valuable aid to diagnosis, and it is well to remember that the sternal end of the second left intercostal space corresponds to the left side of the base of the heart, and the lower margin of the fifth rib to the apex. In a medico-legal sense it should also be known that "when a person is found dead with a wound in the heart, attended with abundant hemorrhage, it must not be supposed that the flow of blood took place in an instant or that the person died immediately and was utterly incapable of exercising any power" (Taylor). The symptoms as well as the duration of life are much influenced by the direction and size of the wound. Thus, if made in the course of the muscular fibres, there will be little or no hemorrhage, and consequently less collapse and dyspnœa; but if the heart be cut across, the edges will separate to a great extent and sudden death ensue from the immediate gush of blood. In oblique wounds there will be less gaping

[1] *Trans. Amer. Med. Assoc.*, 1880.

of the edges. With respect to the cases of recovery, Sanson has recorded an instance in which a cicatrix in the heart was found some lengthened period after the receipt of a wound from which the patient had recovered in twenty-eight days. Velpeau has cited a second, of a man aged 50, who died nine years after having received a wound in the left side of the chest from a table knife, and in whom the pericardium was found largely opened and adherent to the parietal cicatrix, while fibrous lines traversed the whole thickness of the right auricle at a point corresponding to the breach of surface in the pericardium. In the *Medical Times and Gaz.* of April 4, 1874, a case is also reported of a Captain B——, æt. 40, who died from dysentery, and after death a leaden bullet, which had entered the chest above the nipple eleven years previously, was found encysted outside the pericardium, between the origin of the pulmonary artery in front and the ascending part of the arch of the aorta behind. The heart may also be lacerated by a severe contusion or pressure upon the chest without external wound or fracture of the ribs. (Thus at Guy's there is a prep., 1400[15], in which both auricles of the heart are lacerated with the pulmonary veins, which was taken from a child aged four, over whose back the wheel of a cart had passed. There is also another in the Royal College of Surgeons of Edinburgh which demonstrates this point.) The diagnosis and treatment of this form of injury are the same as in cases of wounds.

Treatment.—As hemorrhage after a wound of the heart is the main fear, so to prevent and arrest it should be the chief aim. With this object absolute repose is essential, and the local and general employment of cold should be maintained throughout the case. To calm the excited action of the heart, belladonna and digitalis have been recommended, and so, even, has venesection. The diet should be nutritious, but unstimulating. When the pericardium is full of blood, it has been suggested to lay open the cavity to let it out; but the uncertainty of diagnosis is sufficient to forbid the attempt. For further information on the subject I may refer to Poland's article in *Holmes's Surgery*, which contains an admirable analysis of Fischer's paper; also to a paper by West in the *St. Thomas's Hosp. Rep.*, 1870.

Wounds of the large vessels of the chest are generally fatal, death being immediate in most cases from internal hemorrhage. Dr. Heil, however, records a case in which a man, after receiving a stab which penetrated the aorta, recovered and lived a year. Pelletan also cites another, in which a man was run through with a foil, which entered the chest above the right nipple and came out at the left loin; yet no violent or marked symptoms followed the accident beyond constant pain in the loins. Two months later he suddenly died in great agony from hemorrhage into the right side of his chest, and after death an opening the size of a quill was found in the aorta above the diaphragm. The Hunterian Museum (No. 1565a) contains a specimen of the ascending aorta of a sailor, in which was lodged a bullet in a piece of integument surrounded by lymph. The wound was produced by a musket-ball passing through the diaphragm and pericardium into the aorta; it entered the chest between the eighth and ninth ribs and was followed by a rush of blood. All hemorrhage, however, very soon ceased. The man lived three days after the injury.

Wounds of the Arteries.

When an artery is *completely cut across*, bleeding takes place and the blood jets forth *per saltum*, as it is called, with each pulsation of the heart. Pulsation in the vessel below the seat of injury is likewise lost. The blood is usually of a bright-red color unless the patient be asphyxiated or fully under the influence of some anæsthetic, when it is often as black as venous blood. Pressure upon the artery above the wounds arrests or diminishes the hemorrhage. When an artery is *only partially wounded*, either transversely, obliquely, or longitudinally, the bleeding will probably be less profuse; and the blood rarely jets out as from a divided vessel, but wells up *in a deep wound* or flows in a continuous stream, after the manner of venous blood. When the blood is red, its arterial nature can easily be recognized; but when black, its recognition is more difficult. Should pressure, however, above the wound arrest the flow and pulsation in the vessel below the wound be lost, the probabilities of the blood being arterial are strengthened. It is an important fact to bear in mind that when a large artery is partially divided just *below* a large anastomotic branch, bleeding will take place from the lower end of the wounded artery, as well as from the upper, and pulsation in the vessel below will only be diminished.

When hemorrhage takes place from a large vessel, it is generally, unless instantly checked, so profuse as to destroy life rapidly. When from a small, it is less copious and

has a natural tendency to stop—at any rate, for a time—and to give an opportunity for natural hæmostatics to take effect.

Whatever favors *retraction* of a divided artery and its *contraction* tends to arrest bleeding; whatever hinders these processes prolongs and increases it. Thus, vessels that traverse loose textures cease bleeding more readily than others circulating through those that are close and compact, such as the integument of the head and sole of the foot; and bleeding from an inflamed or rapidly-growing part is checked with greater difficulty than that from other tissues.

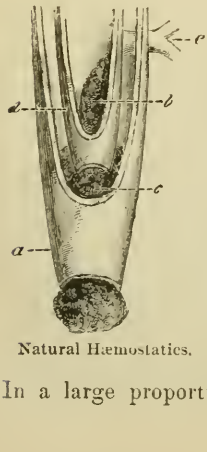
The size and form of the wound in the vessel have also much to do with the result. A *puncture in the axis* of a large artery may heal by natural processes and be unattended by much bleeding; a small *vertical* wound may likewise close, whereas an *oblique* wound will gape, and is consequently attended with copious bleeding; while a *transverse* wound is of all others the most dangerous, on account of the difficulty of controlling hemorrhage and the improbability of natural hæmostatics unassisted by art acting with any permanent advantage. The retracting power of the vessel tends to cause gaping of the wound rather than closure, and encourages rather than checks bleeding.

It is well, therefore, to consider now how wounded arteries heal and by what means bleeding can naturally be arrested.

Repair of Wounded Arteries.—Small wounds of arteries may heal by immediate union or primary adhesion, and larger may likewise for a time be closed by the clot of blood that covers the wound, or even by some stronger reparative material; but "the closure of a wound in an artery is often ineffectual or only for a time, and fresh bleedings ensue, either increasing the accumulation of extravasated blood or pushing out the clots already formed. In this manner, with repeated hemorrhages at uncertain intervals, the wound in an artery is often kept open, and at the end of two or three weeks may show no trace of healing, but rather appear widened and with softened everted edges. In such a case it is possible that the wound in an artery may still *heal by granulations*, either rising from its edges or coalescing over it from adjacent parts, but the *event is too unlikely to justify the waiting for its occurrence* if there be opportunity for surgical interference; and even if healing should go so far as to close the opening in the artery, yet is it likely to be insecure, for both the elastic tissue and the smooth-fibred muscle on which its strength largely depends are very slowly formed in scars. Hence, a form of traumatic aneurism seems not very rare in which the sac is chiefly formed of scar tissue which closed the wound in the artery and then yielded to the pressure of the blood."

Thus a partial is a more serious injury than a complete division of an artery, and requires as prompt surgical treatment, because the means adopted by nature for the permanent arrest of bleeding in a divided vessel are acting at a disadvantage, and are rarely effectual in one only partially wounded. In practice, therefore, the surgeon, by the complete division of a partly divided vessel, often gives natural hæmostatics a fair chance of effecting a cure. Hemorrhage from vessels of small size, as a rule, ceases after the first rush, or, at any rate, as soon as nature's processes for controlling bleeding have had time to act. Indeed, "gradually, with or without surgical help, all the vessels divided by a wound are closed and cease to bleed, the larger being often aided to this end by their retraction among the looser textures, by the coagulation of the blood within or over their orifices, and by the diminution of the heart's force with the increasing loss of blood. Coincidently the flowing blood becomes gradually brighter and paler. And if the wound be left open after pure blood has ceased to flow, there is an oozing of blood-tinged serous-looking fluid, and this is gradually succeeded by a paler fluid, some of which collects like a whitish film on the surface of the wound" (Paget).

Fig. 132.



Natural Hæmostatics.

Natural Hæmostatics.

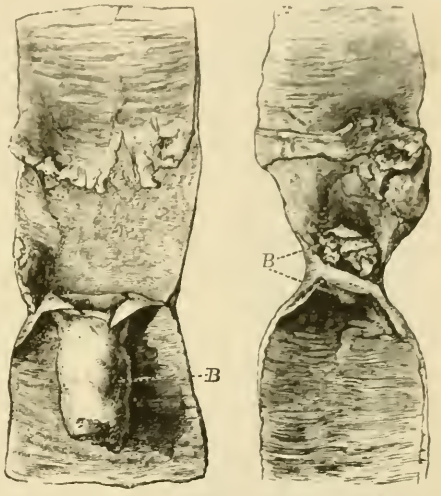
In a Divided Artery.—*When an artery is divided across*, five things happen: (1) The divided ends (Fig. 132 *d*) *retract* within the sheath (*a*), and (2) by *contracting* diminish the calibre of the canal; (3) Blood coagulates *in the sheath* (*a*) around the orifice of the divided vessel, and (4) *in the artery* itself (*b*) up to the first large branch (*e*); and, lastly (5), *plastic lymph* is poured out from the divided coats of the vessel, and by its organization the permanent closure of the vessel takes place. The clot subsequently becomes organized and contracts. In a large proportion of the cases of divided arteries these natural hæmostatic pro-

cesses are ample of themselves for the arrest of bleeding, while it is only in the larger arteries that any surgical or artificial aids are required.

In Torn Artery.—*When an artery is torn across*, the same changes take place; *but they are carried out to an advantage*, as the stretching or torsion of the vessel before it gives way encourages its "*retraction*" and "*contraction*" and the lacerated edges of the vessel help the coagulation of the blood. It thus happens often that such large arteries as the femoral and brachial may be torn asunder and no bleeding follow, and whole limbs avulsed from the trunk without hemorrhage. The lacerated vessel appears under these circumstances as if drawn out, with its external elastic tunic stretched into a conical form over the inner coats that have been divided and retracted. An artery, however large, divided by laceration or torsion consequently rarely bleeds: and it was the observation of this fact that suggested to Amussat the idea of practising torsion of an artery.

In a Stretched and Contused Artery.—*When an artery is contused* or so stretched as to suffer something less than complete rupture of all its coats, it may become obstructed; and this obstruction is probably caused by a more or less complete circular laceration or breaking up of its inner tunics, for the different museums contain preparations which prove that an artery so treated, when apparently maintaining its continuity, may have a complete circular laceration of its inner coats, a separation of these coats from the external cellular one, or an incurvation of these tunics into the lumen of the artery, as in torsion (B, Figs. 133, 134), the deposition of clot subsequently taking place within the meshes of the divided coats, and, as a consequence, the complete occlusion of the vessel.

FIG. 133. FIG. 134.



Laceration and Recurvation of Internal Coats of an Artery from External Injury. (Taken from preparations now in the Museum of the Middlesex Hospital by the kind permission of the surgeons.)

I have known this obstruction to follow many injuries, and have seen the external iliac artery obstructed in a case of a broken pelvis, in one instance followed by gangrene of the lower extremity, and in a second by cure. I have also known the common and the superficial femoral artery, the axillary and the brachial arteries, to become permanently closed in a similar manner. It is a question, indeed, whether, as a result of contusion, adhesive inflammation ever takes place in an artery to cause its occlusion without some such laceration of its inner tunics as has been described.

Sometimes a vessel will rupture, some days after the injury, at a part that has been severely contused, causing a secondary subcutaneous hemorrhage and the sensation of something giving way. Such a result, however, is rare in civil practice, although in military, from gunshot wounds, it is more frequent. The bleeding, under such circumstances, occurs after the fifth day. Cold lotions will generally suffice to induce absorption of the blood when the hemorrhage is slight, although in some cases the fluid blood may be drawn off with a good result. In exceptional cases an aneurism may form and require treatment.

Surgical Hæmostatics.

It has been asserted that by natural processes alone divided vessels are permanently sealed and arteries in continuity occluded; it will be well, therefore, to inquire into the modes of action of the different means which the surgeon has at his disposal to bring about these results, since it may be stated *in limine* that the means are to be regarded as good in so far as they aid and turn to account the natural processes that have been described.

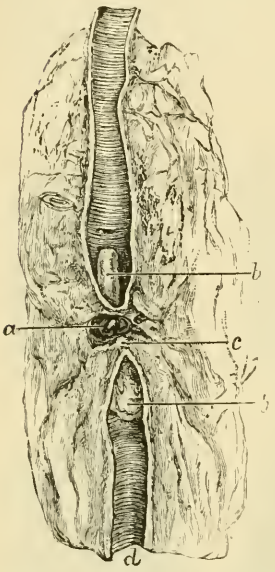
Thus, *the exposure of, and the application of cold to*, a divided artery favor its "contraction," this physiological explaining the practical fact that on the free opening of a wound hemorrhage often ceases, never to return.

Pressure upon the end of a wounded artery favors "coagulation" in the vessel, and the value of *acupressure* rests mainly upon this principle, the pins and pressure mechan-

ically arresting the flow of blood, whilst coagulation is taking place in the vessel up to the first branch.

When a ligature is applied firmly to an artery, the inner coats are usually more or less regularly divided and the outer is so constricted as to arrest the current of blood through the vessel. The blood thus arrested consequently coagulates and forms a clot or thrombus, which is, as a rule, conical, with its base toward the ligature and apex pointing to and reaching the first branch (Fig. 135, *b*). This clot subsequently contracts and becomes organized. The inner and middle coats, from their divided edges, pour out (*c*) plastic lymph, which heals the wound and eventually cements together the outer and inner coats and the clot into one homogeneous mass; and if in the sequence of events nothing occurred to interfere with the steady evolution of this reparative process, all would indeed be well, but unfortunately such is not always the case, for the ligature has often to come away. To this end the outer coat of the artery, where constricted, must slough or ulcerate, and the vessel itself, in either case, at the line of ligature thus becomes divided. By such action, therefore, what nature by the processes already described might have well done too frequently becomes undone; and unless a firm clot has filled both ends of the artery or plastic lymph become organized around the divided coats, the risks of secondary hemorrhage are very great. It is this fact which makes the practice of arresting hemorrhage by means of the silk, hemp, or wire ligature so unsatisfactory. To Stilling and Dr. J. F. D. Jones, 1805, we are indebted for most of our knowledge on these points.

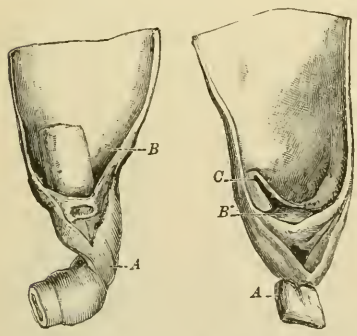
Fig. 135.



Effects of Carbolized Catgut Ligature on Common Femoral Artery. (Taken from a girl æt. 19, who died on the twentieth day, from gangrenous leg, after the application of the ligature to the artery for elephas. The ligature in this case was firmly attached to the vessel and had acted upon its coats as a permanent ligature.)

When the carbolized prepared catgut ligatures are employed, the primary effects of the ligature are the same as with the permanent (*vide* Fig. 135; *Trans. of Clin. Soc.*, 1878), but the secondary changes which have been described do not of necessity follow. The prepared catgut ligatures, consequently, may be regarded as temporary ligatures which may either dissolve within a few days of their application or become loose. If, therefore, an artery to which such a ligature has been applied does not become permanently closed by natural hæmostatic processes before the ligature has dissolved or become loose, the circulation through the vessel may be restored or secondary hemorrhage may ensue; and this accident has occurred. The prepared catgut ligature is not, therefore, so safe as torsion for divided arteries. It is, however, a safer ligature than the silk or hempen, as it does not, like the latter, of necessity require an ulcerative process for its discharge.

Fig. 136.



Effects of Torsion upon an Artery, showing the Incurvation and Laceration of the Inner Coats. (From paper by the author, *Med-Chir. Trans.*, 1868.)

Barwell's flat ox-aorta ligature occludes an artery by mechanically holding its coats together, and its safety depends upon the coagulation of the blood in the artery and its power of holding long enough to give time for the organization of the clot. With it there is no division of the inner coats of the artery. I do not, therefore, believe it to be as safe as the prepared gut or silk ligature.

The Effects of Torsion on an Artery.—*When an artery is closed by what is termed torsion*, the inner coats are ruptured (Fig. 136, B and C), and the outer (A), when not twisted off, closed by the twists to which it has been subjected. But the inner coats, instead of being simply divided in a linear manner, as occurs when the ligature is used, become ruptured, separated from the outer coat, and incurved, their divided ends turning into the vessel and in the most perfect examples forming complete vessels not unlike the semilunar valves of the heart. The blood, which is consequently arrested by this valvular incurvation of the inner tunic, undergoes changes

precisely similar to those already described. Plastic lymph is poured out by the divided tunics in the same way as has been shown in the application of the ligature, and it acts the same part in cementing all the arterial tunics and clot together. Between the two forms of practice, however, there is this difference—that where the permanent ligature has been used ulceration of the vessel is prone to occur to allow of its escape, and thus may undo all that nature has done to seal the artery and prevent hemorrhage; whereas, when torsion has been efficiently performed and the hemorrhage arrested, no subsequent action is liable to undo the good work that has been done or to hinder the permanent closure of the vessel. With both ligature and torsion natural hæmostatics are aided in their work, but with the former the ulceration set up by the ligature may materially interfere with the perfection of the process, while with the latter there is nothing to prevent the process going on to its completion.

On Hemorrhage and its Treatment.

When bleeding takes place rapidly from a wound after an injury or operation, it is called **primary**; when it occurs on reaction from shock within twenty-four hours, or in rare cases within two days, it is called **recurring** or **intermediary**; and when after a lapse of a longer period, **secondary**.

The *primary* is due to the direct injury of the vessel; the *recurring*, to the increased force of the circulation during reaction and the displacement of clots that were sufficient to seal vessels when the circulation was feeble, to the overlooking of a vessel during the dressing of a wound, or to some imperfection in the mode of securing it at the time of operation. The *secondary* is caused by the giving way of an artery or vein, by ulceration of the ligature, by sloughing of the vessel alone or with the tissues around by the accidental separation of a ligature, injury, or owing to the hemorrhagic diathesis.

When blood escapes from a wound externally or into a cavity, the term *hemorrhage* is applied; when it is effused beneath the integuments or amongst tissues, *extravasation* or *effusion* is said to occur.

The SYMPTOMS of external hemorrhage require no description, the slow flow or the sudden gush of the life's blood being recognizable by all. Those of concealed internal hemorrhage or extravasation require, however, some attention. They are those of local injury *plus* those general symptoms which denote hemorrhage generally.

"In slow and in sudden hemorrhages," wrote John Bell seventy years ago, "the symptoms are very different. In the former the patient is very slowly exhausted; at each return of bleeding the patient faints and is laid in bed and the cold applications and the fainting save his life. He rises, after some days, pale, languid, and giddy. The pulse flutters and is hardly to be felt; the breathing is quick and anxious, accompanied with sighing and great oppression; the heart palpitates on the slightest motion, and the slightest inclination of the head or rising suddenly from the couch endangers fainting. The voice is low; the eye is languid, colorless, and of a pearly white; the flesh feels soft and woolly, and the skin is pale, yellow, gelatinous, and, as it were, transparent, like modelled wax. After this stage of weakness the blood loses its color; from this time forward it is a bloody serum only that distils from the vessels; dropsy appears and the slightest loss of blood proves fatal. But when the patient expires suddenly by an impetuous bleeding from some great artery, when he dies of the bleeding from a femoral aneurism, when he is wounded among the viscera and some great vessel is pouring out blood, the blood in the general circulation, in place of being forced onward by the contractions of the arteries, runs backward toward the wound from all parts of the body. The arteries no longer push on the contents of the veins; the blood ceases to flow toward the heart; the heart ceases to act, and the countenance assumes, as in asphyxia, a livid hue, from want of circulation. The face becomes all at once deadly pale; the circle round the eyes is livid, the lips are black, and the extremities are cold. The patient faints, revives, and faints again, with a low and quivering pulse; he is sick and his voice is lost. There is an anxious and incessant tossing of the arms, with restlessness, which is the most fatal sign of all. He tosses continually from side to side; his head falls down in the bed; he raises his head at times suddenly, gasping, as it were, for breath, with inexpressible anxiety; the tossing of the limbs continues; he draws long convulsive sighs; the pulse flutters and intermits from time to time, and he expires. The countenance is not of a transparent paleness, but that of that clayey and leaden color which the painter represents in assassinations and battles; and this tossing of the limbs, which is commonly represented as the sign of a fatal wound, is, indeed, so infallible a

sign of death that I have never known any one to recover who had fallen into this condition" (*Principles of Surgery*, vol. i. p. 143).

This sketch is so graphic that I have extracted it as a whole. Since my student days, when I first read it, it has been fixed in my memory. It is, however, only a page out of the work of a master-surgeon which still deserves close study.

A patient may lose a large quantity of blood and yet rally. Children bear the loss of blood badly, yet rally quickly. In old age a small hemorrhage is of grave importance, the rallying-power being very small.

Treatment.—To treat a case of arterial hemorrhage successfully, the surgeon, wrote Robert Liston, "must learn to look boldly on the open mouths of arteries." He must know, moreover, that hemorrhage from any vessel, however large, is readily controlled by the application of well-applied direct pressure *upon the wounded part;* consequently, any surgeon on being called to a case of wounded artery, having cleansed the wound and exposed the vessel, should put his thumb or finger on the bleeding orifice and check the flow until more permanent hæmostatic methods can be adopted. When moderate bleeding comes from a wound and its source is unknown, whether arterial or venous, the mere act of *cleansing the wound and removing clots* is often sufficient of itself to arrest bleeding, not only for the time, but permanently. When the bleeding is venous, *the elevation of the limb* has always a most beneficial and rapid action. When *direct pressure* is employed to check bleeding, it should be well applied; a small and compact pad corresponding in size to the last joint of the thumb should first be applied to the bleeding part, and over this a larger one should be carefully adjusted, a third covering in the whole. These are to be firmly bound down over the bleeding vessel with a bandage or some unyielding strapping, care being taken that the pressure employed is sufficient to control the bleeding, but not enough to arrest wholly the circulation through a limb, thereby producing gangrene of the parts below.

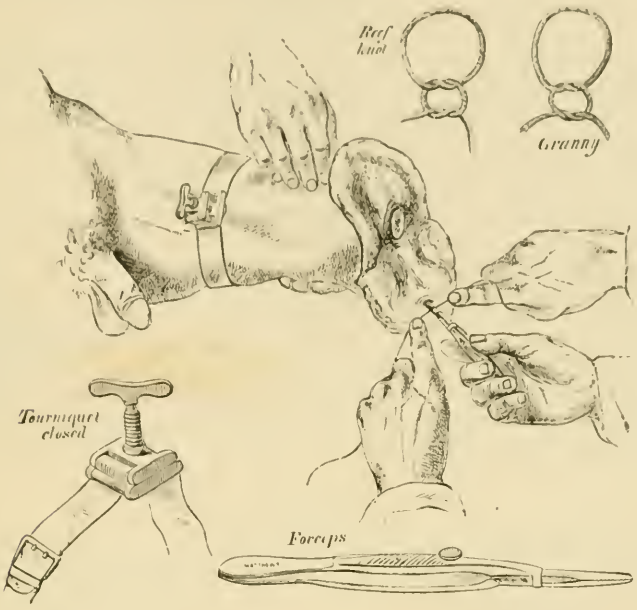
When direct pressure is inapplicable, *indirect pressure*, as it is called, may be applied to the main artery of a limb above the wound, and for *temporary* purposes this may be efficiently performed by the thumb or finger of the surgeon or of a skilled assistant; but for a lengthened period this method is untrustworthy, it being impossible for any ordinary man to maintain firm pressure upon a vessel for more than a few minutes consecutively. As a temporary means of arresting bleeding, however, manual pressure is of immense value and should be applied to the femoral artery below Poupart's ligament for the lower extremity, and on the inner side of the biceps muscle for the upper, the fingers or thumb of the surgeon being employed, according to convenience. In some cases the use of the weight, as shown in Fig. 149, may be recommended.

What is known as Esmarch's method of arresting hemorrhage has in recent times met with considerable support. It consists, first, in the application of an elastic bandage from the extremity of the limb to be operated on to a point above the site of the operation; and secondly, in the adjustment of an india-rubber band or tube tightly above the upper border of the elastic bandage, which can then be removed. By this method the parts below the band have been rendered bloodless, and the surgeon may explore a limb, excise a tumor, joint, or bone, and even amputate, with the loss at the time of a spoonful of blood. The method has, however, one objection; which is, that when the band is removed blood oozes from the soft parts to a far greater extent than it does under other circumstances, the smaller vessels apparently becoming paralyzed by the compressing bandage or from having been completely emptied. The operation, which is bloodless during the cutting process, is, on the whole, therefore, followed by the loss of as much blood as generally follows other methods. All the good of this method, without the evil, may, however, be obtained in an amputation by raising the limb for a few minutes before the application of the elastic tourniquet and smoothing heartward with the hand the soft parts, to empty the veins. I feel bound to add that this method of emptying a limb of venous blood before amputation was practised at Guy's by the late Mr. Aston Key in 1849, when I was his dresser, in a case of compound fracture which required amputation, and in which it was necessary that the loss of blood should be reduced to a minimum. The case did well. The late Mr. Hilton subsequently often adopted the practice. For exploratory operations and the removal of small foreign bodies, excision of joints, and removal of necrosed bone, the compressing bandage has, however, great advantages.

The tourniquet is doubtless an excellent instrument for the compression of an artery, and J. L. Petit's is probably the best for the extremities. It should be applied to the limb directly over the vessel to be compressed, the pad being adjusted in the axis of the vessel. The ends of the band are then made to pass round the limb and are secured

either by a buckle or a knot, the former being preferable. The two plates can then be separated by the rotation of the screw and a sufficient amount of pressure employed to stop the current of blood, and no more (*vide* Fig. 137). Lister has invented an admirable

FIG. 137.



tourniquet for compressing the abdominal aorta, and many others have been constructed; but these are ample for all ordinary purposes of arresting or preventing hemorrhage.

When a tourniquet is not at hand, as in the field, a stone or any hard substance may be rolled up in a handkerchief, applied over a vessel, and bound round the limb; the ends of the handkerchief, too, should be attached to a stick or sword, any amount of compression being obtained by simply twisting them.

As *temporary* means of arresting hemorrhage, therefore, the surgeon may employ digital or instrumental pressure either upon the bleeding spot—*i. e.*, *direct*; or upon the main artery of the part—*i. e.*, *indirect*. The wound in both cases should be well exposed and cleansed and all coagula removed preparatory to the application of such permanent means as may be at command. Of these, the *ligature*, *torsion*, and *acupressure* are the chief. Stypties and the cautery are only employed when the three means mentioned are either inapplicable or have proved unsuccessful.

On the Use of the Ligature.

Since Ambrose Paré reintroduced the use of the ligature (1550) it has been the favorite means for the arrest of hemorrhage, the speedy way in which bleeding from an artery, however large, is checked by its application, and the feeling of relief experienced on knowing that for a time at least all fear of bleeding has been removed, having so influenced the majority of practitioners in its favor as to induce them to put aside untried all other suggested means as being unnecessary. It took, however, more than two centuries for the ligature to become established in practice; in fact, its adoption was not general till Dr. J. F. D. Jones had demonstrated by his experiments, already alluded to (p. 342), the physiological processes by which hemorrhage is naturally arrested in a bleeding vessel, and that by the ligature these were utilized.

To tie an artery efficiently, the vessel should be taken up cleanly, drawn out, and tied with a smooth cord of prepared silk or catgut with sufficient force to rupture the inner coats of the vessel (such a result, although desirable, does not appear, however, to be constant) and occlude the outer coat; the ligature should be made secure by what is called the sailor's reef-knot; the surgeon's double-knot should not be used. In forming the loop the ligature should be pressed down to the artery by the finger or thumb, as indicated in the drawing (Fig. 137); otherwise, the extremity of the artery will, if diseased, be liable to be broken off.

When the vessel is deeply placed and cannot be isolated, it must be ligatured with some of the adjacent tissues. When it is so embedded that its free end cannot be taken up with forceps, a tenaculum may be passed beneath the bleeding vessel, and all the tissues taken up by the instrument should be strangled by the ligature. The ends of the ligature used to be left hanging out of the wound, but at the present time the practice of the late Mr. de Morgan, which is a revival of that of the last century, of cutting off both ends of the ligature, leaving the knot *in sitû*, and closing the wound, has become general.

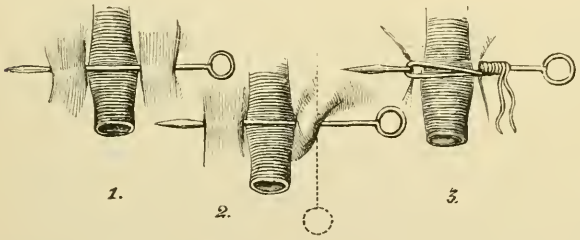
When the vessels are diseased and brittle, extra care is needed in the application of the ligature. The vessel should not be tied too tightly lest too much of the artery be torn and the ligature be made to separate before natural hæmostatics have closed it. Some have suggested the use of a flat ligature under these circumstances, but it seems scarcely needed. In 1865 I was called upon to apply a ligature to the femoral artery of a man over seventy years of age for femoral aneurism. The vessel was so brittle that I felt the coats give way on the application of the ligature; the included tissue, too, seemed so thin that I expected to find the ligature come away in my hand, which did not occur. The case ultimately did well, and no bleeding ensued.

When a vessel is wounded, the artery is to be secured at the seat of injury by a ligature applied above and below the wound. Some surgeons then advise the division of the vessel between the ligatures. Dr. J. A. Lidel of New York, in his able article on "Injuries of Blood Vessels," in the *International Cyclopædia of Surgery* (vol. iii. p. 81), speaks decidedly upon this point, giving as his reason, "so that both ends of the divided vessel may be able to retract."

Acupressure.

The late Sir James Simpson brought this method of arresting hemorrhage before the profession in 1860, and on his authority many resorted to the practice. The late Mr. Pirrie of Aberdeen gave it his warmest support, but since his death the practice has been given up except in rare cases. The principle of the practice is very simple—viz., the occlusion of the artery by the temporary pressure of a pin without lacerating the vessel or setting up inflammatory and suppurative action, as in the ligature. The pin is removed on the second or third day, according to the size of the artery. The advantages thus claimed for it are very great, but experience has not decided in its favor. There are three leading forms of acupressure.

Fig. 138.



Different Modes of Applying Acupressure.

In the *first* the artery is directly compressed between the pin, which crosses its free end, and the muscle beneath (Fig. 138, 1).

In the *second* the same result takes place, the pin being made to give a half twist through the tissues between its first and second insertions (Fig. 138, 2).

In the third the pin is simply passed beneath the vessel and pressure applied to the artery by means of a loop of wire or silk looped over its point and made to cross the vessel, the ends of the loop being secured upon the shaft of the pin (Fig. 138, 3).

The *good* point in acupressure is the absence of any foreign body for more than a few hours or days. Its disadvantage lies in the fact that its success depends upon the coagulation of the blood in the vessel down to the first branch—one of nature's temporary hæmostatic processes—and not upon the permanent closure of the coats of the vessel. As a consequence, it is not so secure as the ligature, or physiologically so sound as the practice of torsion. As a mode of temporarily arresting hemorrhage in certain cases where the ligature and torsion are inapplicable, as in wounds of the palm or the sole of the foot, it is indeed valuable, and particularly, also, as a means of arresting the flow of blood from a leech bite or other bleeding point, the passage of a needle through the skin and a figure-of-8 ligature over being of great service.

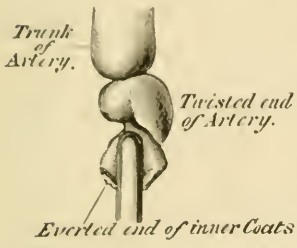
An ingenious modification of this process has been devised and successfully used by Mr. Dix of Hull. A wire passed through the flaps by means of two needles and twisted over a cork outside compresses the bleeding vessel in the same way as the needles. It is

called by its author "the wire compress," and is fully described in the *Edinburgh Medical Journal*, September, 1864. It seems, however, to be more adapted for securing an artery in its continuity, as in the treatment of aneurism, under which head it will be described in detail.

On Torsion.

In a physiological point of view, there is no method more perfect at command for the control of hemorrhage than that of torsion, because, unlike acupressure, which uses one only of nature's hæmostatic processes, or the ligature, which is a foreign body in a wound and becomes a source of danger by undoing at a later what has been done at an earlier period of the case, it utilizes to the utmost all the physiological processes employed by nature to prevent and arrest bleeding and places the vessel in the most favorable position for them to take effect (*vide* page 340).

Fig. 139.



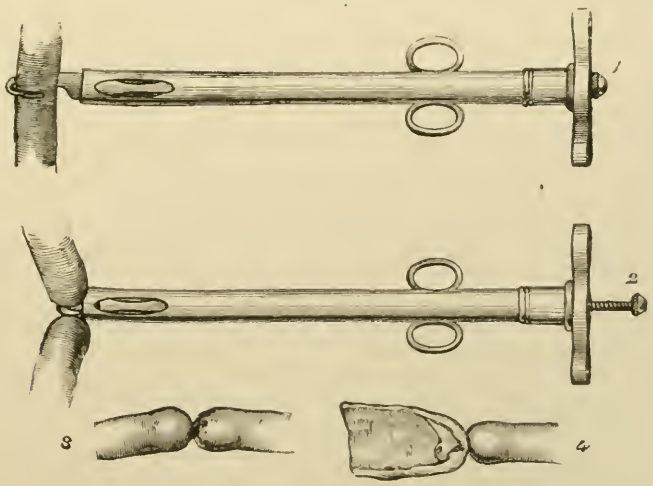
Effects of Torsion on Femoral Artery.

For the application of torsion a good pair of forceps is required (*vide* Fig. 137) that will hold the end of the artery firmly, that has no lateral motion, and with serrations blunt enough to obviate any laceration or cutting of the parts seized by the blades. The vessel should then be drawn out, as in the application of the ligature, and three or four sharp rotations of the forceps made. In large arteries, such as the femoral, the rotation should be repeated till *the sense of resistance has ceased*. The ends should not be twisted off. In small arteries the number of rotations is of no importance, and their ends may be twisted off or not as may be preferred. In Fig. 139 the appearance of a femoral artery sufficiently twisted is well shown.

When the vessels are diseased, fewer rotations of the forceps are required, the inner tunics of the vessels being so brittle as to break up at once and incurve. If the surgeon, therefore, twist more, he will break away the external or cellular coat, which is of essential importance not only in maintaining the lacerated inner coats in position, but in allowing blood to coagulate and lymph to organize between them. With this caution, diseased arteries appear to be as amenable to the treatment as the healthy; and torsion requires no more care under these or any circumstances than the application of a ligature.

The physiological arguments in favor of torsion are numerous, while the practical advantages seem to be not less. After fifteen years' experience of the practice among

Fig. 140.



1. An artery taken up by the constrictor. 2. Artery constricted. 3. Effects of constriction upon vessel. 4. As seen when laid open.

vessels of all sizes (the femoral being the largest), I have had no mishap. I have further observed that wounds have united more rapidly and kindly, primary union being the rule; there has been less constitutional disturbance after operation, and consequently less liability to traumatic fever, pyæmia, and other complications such as we are all too familiar

with in the practice of surgery. Stumps have healed in a week and patients been up in two without one single drawback, rapid and uninterrupted convalescence following the operation. In other cases equally good success can be recorded. At Guy's Hospital we have had two hundred consecutive cases of amputation of the thigh, leg, arm, and forearm, in all which the arteries had been twisted (one hundred and ten of them having been of the femoral artery), and no case of secondary hemorrhage.

The Artery Constrictor.

Dr. Fleet Speir of Brooklyn, New York, has had an artery constrictor made (Fig. 140) which, as he has demonstrated upon both the living and the dead, has the power of dividing the inner coats of an artery and allowing them to recurve as in torsion. He has used it on all the larger vessels except the iliac and subclavian, and has never had any trouble, union chiefly by first intention having followed (*Med. Mirror*, New York, April, 1871, and *Archives of Clinical Surgery*, September, 1876).

The instrument he recommends (Fig. 140) should be "tight-fitting enough to constrict thoroughly, and yet grooved and smooth enough *not to lacerate* the external coats, while it makes a *complete invagination* of the inner coats. For operating upon vessels in continuity, as for aneurism, I prefer to place the limb, after constriction, in a relaxed position, so as not to stretch the vessel after being constricted."

In Fig. 140 the instrument is shown applied to an artery, and in Fig. 140 (4) a section of the artery subsequent to its constriction. I have tested this instrument on the living and have made a large number of experiments on the dead, and find it does all that Dr. Speir asserts. I believe it to be of value for obstructing arteries in continuity, as it does for such precisely what torsion does for divided vessels. In May, 1882, I employed the instrument with encouraging success in the case of a man æt. 48 with popliteal aneurism.[1] The wound healed by "quick union," and the aneurism was cured.

Other Methods.

Astringents or styptics are valuable agents in the arrest of bleeding when the means previously mentioned are inapplicable, their value being much increased when combined with pressure. The perchloride or persulphate of iron, pounded matico, alum in powder or solution, applied to a bleeding surface on a pad of lint or dossil of cotton-wool and bound on, are the best applications, though tannic acid, Ruspini's styptic, or oil of turpentine is also serviceable. Before applying any of these the bleeding part should be wiped as dry as possible and all coagula removed. In uterine surgery injections of some of these astringents are much used. In rectal surgery the bowel may be plugged with lint or sponge saturated with a styptic, and in epistaxis the nose may be plugged in a like way.

"Cold" is a powerful styptic, cold air often permanently arresting even copious hemorrhage on laying open a wound. A stream of cold water directed to a bleeding part, or ice pounded and placed in bladders or bags and laid on bleeding wounds, is at times of great assistance. "Heat," also, is equally good, and when applied in the form of a hot sponge wrung out of an iodine or antiseptic lotion is enough to stop all capillary oozing. I have adopted this practice after operations for some years with excellent success.

Cauterization, which was the common mode of arresting bleeding by the ancients, is now seldom employed; yet it is a valuable agent in cases where neither torsion, ligature, nor acupressure is available. In spongy tissues from which blood is oozing, and also in other cases, the hot iron will often act most beneficially. It may be applied through iron buttons or cones brought to a *black heat* by means of fire, or through platinum or porcelain instruments heated by means of benzoline vapor or the galvanic battery. In any case the heat should be enough to cause a dry eschar upon the bleeding part, while care should be exercised subsequently not to remove this too soon; indeed, the eschar scab should be left for natural processes to throw off. In no case should the cautery be too hot—that is, *red hot*—as it destroys the vessels too much. It should be merely of a *black heat*.

Capillary Hemorrhage.—Hemorrhage from the *capillaries* or small vessels rarely takes place to any dangerous extent unless it occurs in "bleeders" or such as labor under the hemorrhagic diathesis. It has always a tendency to stop by itself through such natural hæmostatic processes as have been described. If, however, it be

[1] *Brit. Med. Journal*, vol. ii., 1882.

too persistent, the surface of the wound should be exposed and cleansed, the stimulus of the air being often sufficient to excite closure of the vessels. Moderate pressure upon the surface of the wound or a stream of cold water over it is also a valuable auxiliary.

Summary of Treatment of Hemorrhage.

All divided or wounded arteries from which blood flows are, if possible, to be twisted or tied at the seat of injury; and to accomplish this, when room is required, the wound may be enlarged. When an artery is *divided, both ends* are to be dealt with separately. When an artery is *wounded*, John Hunter's advice is still sound: "First apply the tourniquet, then lay the artery sufficiently bare, and tie the vessel above and below the wounded part" (MS. Lect., 1787). In some cases the vessel had better be completely divided; with the brachial I have followed this practice on three occasions, and twisted its two ends, with good result, and advise its adoption as a rule of practice in arteries of less calibre. In larger arteries it is also probably good.

When there is no bleeding present, an operation is not required, although, in exceptional cases, when a renewal of the hemorrhage may endanger life, this rule may be deviated from.

When **moderate** arterial hemorrhage exists and the artery cannot be taken up in the wound without an operation, the graduated compress may be employed with a fair chance of success; but should it fail, the vessel must be secured.

When arterial hemorrhage endangers life and the artery cannot be treated at the wound, the trunk of the vessel is to be secured above the wound.

When **recurring** hemorrhage is severe, the wound is to be reopened or enlarged, all clots turned out, and the vessel tied or twisted. When moderate, it can be treated by elevating the part, by pressure over either the main trunk of the vessel or the wound, and by the application of cold, such as the ice-bag.

At times all bleeding ceases on the mere exposure of the open wound; at others there is merely a general oozing. Under these circumstances, if exposure of the wound to the air or to a stream of cold water fails to check it, well-applied pressure will often suffice. In exceptional cases stypties may be required.

Secondary hemorrhages are to be dealt with in the wound as primary—that is, when bleeding is profuse, the artery is to be religatured or twisted at the bleeding point; when not severe, it will probably be restrained by pressure and the elevation of the part, since in a general way, when secondary hemorrhage takes place after the application of a ligature to a wounded artery, the bleeding comes from the lower end of the vessel. Guthrie has clearly shown that in the lower end of a divided vessel repair is less perfect than in the upper, that there is less contraction and retraction of the vessel, less perfect coagulation of blood, and less effusion of plastic lymph.

Venous Hemorrhage, unless from the trunks of large veins, quickly ceases, usually from the collapse of the veins. Where any impediment exists to the return of the blood from the wounded part, it may, however, prove troublesome, yet its arrest will probably be secured on the removal of the obstruction. The elevation of the wounded part will tend much toward this end, as will also the application of cold or firm pressure upon the spot.

When large veins are divided and the bleeding is copious, they must be tied or twisted. When veins are wounded, they should be divided and tied; to close a small opening into a large trunk with a fine ligature is not safe practice. Wounds of veins heal rapidly, as is seen after venesection.

Injuries of the large venous trunks, however, are of grave importance, and any wound or injury that induces, directly or indirectly, the complete arrest of the venous circulation through one of these is probably of greater consequence than the wound of an artery. The internal jugular vein has, however, often been tied with success.

A vein is known to be opened when black blood flows from the wound in a steady stream and from its distal part, when pressure above the wound increases the flow and pressure below retards or stops it.

Phlebitis is the chief evil to be feared from an injury to a vein; and when it occurs, it is very fatal. Veins, however, will doubtless bear much more manipulation without any such danger ensuing than our forefathers believed.

The entrance of air into a wounded vein is a source of great danger; but the subject will receive attention in a succeeding chapter.

Ulceration of arteries in contact with pus occasionally occurs in feeble subjects;

and when the artery is large, death may follow. I have lost a case of iliac abscess from this cause, the deep circumflex iliac artery having been opened; many similar examples are on record. When the hemorrhage is recognized and the source of bleeding known, an exploratory incision is called for; the opened artery should be treated as a wounded one.

The General Treatment of Hemorrhage,

though of importance, is subsidiary to the *local*. When *syncope* has taken place from loss of blood, the surgeon should not be too hasty to overcome it, since it is, without doubt, one of the most valuable means nature employs to check bleeding and to assist natural hæmostatics; but, at the same time, great care is needed that the syncope be not fatal. If such an event appears imminent, the patient should be kept in the horizontal posture with the head low; cool air should be allowed to blow upon the face or cold water sprinkled over it; some diffusible stimulant, such as ammonia, ether, chloroform, or the nitrate of amyl, may be inhaled, or brandy given in small quantities. In extreme cases some surgeons advise pressure being made upon the abdominal aorta or large arteries, to confine the blood to the nerve-centres, or even transfusion may be employed. This operation, however, has never been in high favor with surgeons, though from accoucheurs it has received considerable support, the late Dr. James Blundell having given it his energetic advocacy. When attempted, it should not be delayed until too late—*i. e.*, till the hope of rousing the nervous and circulating system has become almost forlorn. Under all circumstances plenty of bland liquid nourishment should be given, such as milk, eggs, broths, etc., and stimulants in moderation. When there is a prospect of a recurring hemorrhage, all food should be given cold. In the convalescing stage iron and quinine, ammonia, and bark are of the greatest value. Opium is a drug that must not be forgotten, as in the restless stage of bloodlessness its action is most beneficial. It must, however, be administered with caution; for with a feeble heart large doses are apt to depress. Half-grain doses repeated at intervals are probably the safest; larger, however, may at times be given. When capillary bleeding takes place to any extent after an operation, a full dose of opium, say a grain, is often very valuable.

When the hemorrhagic diathesis exists, iron in full doses is of great service, the tincture of the acetate or perchloride in half-drachm doses being the best. Oil of turpentine is likewise a valuable remedy, twenty-minim doses being sufficient for an adult. Gallic acid in ten-grain doses and acetate of lead in one-grain doses are also beneficial. All these act upon the blood and dispose it to coagulate.

Transfusion.

When Dr. Lower of Oxford, with Sir E. King, in 1665, first practised transfusion, blood was drawn from an artery and conducted *directly* by means of a tube into the vein of the patient, the blood being propelled simply by the force of the circulation of the emitter. As time progressed the inexpediency of opening an artery was felt, and the plan of transmitting blood from vein to vein came into use. In 1785 this plan was also warmly advocated by Dr. Harwood of Cambridge. With this change of practice the mode of operating had to be altered, because the force of the venous circulation was found to be insufficient to propel the blood. The *indirect* or *mediate* mode of operating consequently came into use, the blood of the emitter being received into a vessel and transmitted by a tube or syringe into the vein of the patient. To James Blundell is due, undoubtedly, the credit of having devised an apparatus by which the operation can be efficiently performed. He called it first an "impeller," and when improved a "gravitater."[1] Since his time Drs. Aveling, Hewitt,[2] Braxton Hicks,[3] and particularly Roussel, have done much toward rendering the practice more safe and certain. The object of the surgeon in the operation is to transfuse blood from a healthy into a bloodless patient, and his aim should be to prevent the coagulation of the healthy blood during the operation, as well as to guard against the introduction of air into the veins. This operation should only be undertaken when a trustworthy apparatus is at hand, and of these Dr. Roussel's is, without doubt, the most complete. Aveling's, however, is excellent.

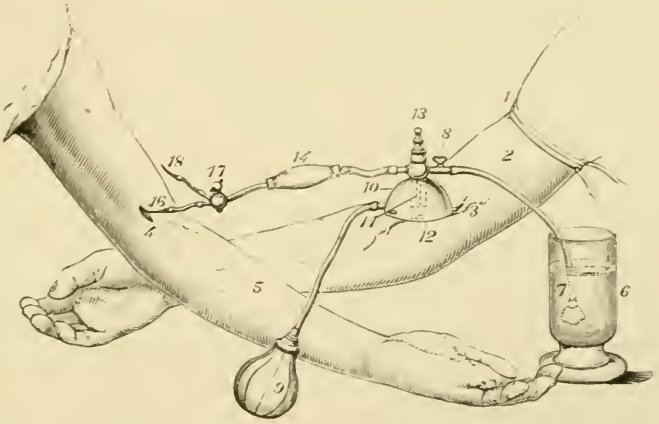
Dr. Roussel's instrument is made of hardened pure caoutchouc; it is composed of a tube with a Higginson's syringe large enough to contain two and a half drachms of fluid (Fig. 141, 14) in its course. One end of the tube is attached to a rigid cylinder (10) open at each end and applied over the seat of the vein required to be punctured (3),

[1] *Lancet*, 1829. [2] *Obstet. Trans.*, 1865. [3] *Guy's Rep.*, 1868.

which has been obstructed by the band (1). The cylinder is fixed in position by being surrounded by a rigid cup, which can be exhausted by an elastic pump (9) in connection with it. The exhaustion of this cup not only fixes the apparatus to the arm, but also increases the turgidity of the vein over which it is applied. The cylinder within it (11) is then closed by the introduction at its upper extremity of a lancet (12), the exact depth of which can be regulated (13). Before operating the air should be driven out of the cylinder and tube by filling them with tepid water (6), in which a little bicarbonate of soda may be dissolved, by means of the syringe (9) and the tube (8 and 7), which is attached to the cylinder opposite to the conducting tube (17). When about to operate, the lancet (12) is depressed into the vein.

To the extremity of the conducting tube a stopcock (17) with two cannulæ (16 and 18) is attached, the stopcock being inserted to direct the flow of fluid into one or other of the cannulæ. One of these cannulæ is introduced into the vein of the recipient (5). The apparatus (10) being filled with water, the vein is opened by the lancet and the contents of the cylinder and tube are pumped out through the free canula (18) until blood only flows through it. The stopcock (17) is then turned, and the blood is injected into the patient's arm through an opening in the vein (4). The syringe by this apparatus forces "the blood into the vein of the recipient by degrees as it draws it from the vein

Fig. 141.



Dr. Ronss-I's Injecting Apparatus.

of the donor, every particle of it having remained less than a second out of the human vessel, enclosed in a full tube, and the blood conducted by an artificial vein and heart hermetically closed, damp, warm, and soft as are the human vessels. The blood is not modified as regards its fibrine, globules, gas, temperature, or density; it passes from one system to another with all its primitive vitality, and continues to live on."

Not more than six to nine ounces of blood should be transfused at one time; the injection, too, should be gradual—that is, about six syringefuls a minute.

DISEASES OF THE ARTERIES.

Arteritis.—Under this heading, besides the rarer forms of disease, we shall include atheroma, as there is no longer any question of its inflammatory nature. Of this Virchow, Billroth, Wilks, and Moxon have given sufficient evidence, though in modern textbooks the old view is still taught and the weight of Gulliver's investigations (*Med.-Chir. Trans.* vol. xxvi.) has not yet lost its influence. We by no means think that Gulliver was altogether in error in holding that atheroma was a fatty and calcareous degeneration of the inner and middle arterial coats, with subsequent thickening of the adventitia: on the contrary, it is not improbable that atheroma may sometimes be a simple retrograde metamorphosis of the arterial tissues: but there can be no doubt that it more often begins as a subinflammatory process. This conclusion has been reached partly upon histological grounds and from the fact that the disease is most prone to occur where the wear and tear is greatest, and inflammation, consequently, most likely. Syphilis has doubtless much to do with arterial disease, and, as a consequence, with aneurism: and the frequent association of syphilis and aneurism in the army has been adduced as strong

evidence in favor of the conclusion. Mr. Myers has, however, shown (*Path. Trans.*, vol. xx. p. 134) by comparing the army with the navy, where syphilis and overexertion are about the same, that in the former aneurism is fifteen times as common as it is in the latter; and he believes that the constriction of the collar and coat of the soldier, by obstructing the blood stream, favors arterial disease more than syphilis.

Arteritis is usually described as "acute" and "chronic," and it will be well for us to adopt the terms in general usage. But the student must remember that the pathologist applies the one to a process the product of which is cellular or nuclear, the other to that which shows organized or tissue product or some degenerative change such as the calcareous, which must necessarily have taken some time in its production. From a clinical point of view, both terms are more arbitrary than exact; and there is other evidence than pathological to show that changes judged by such a standard to be chronic are rapid in their course, and, in the same way, others which must be called acute, in that microscopically they are cellular, are not necessarily of short duration. If we, then, continue to describe arteritis as acute and chronic, it is evident that no strictly histological basis is broad enough for accuracy; and we have therefore adopted that classification of acute arteritis which accords best with our own experience.

Acute arteritis is found under four conditions:

1st. As slightly raised grayish or pellucid patches on the lining membrane of the artery, which when examined microscopically show a multiplication of the cells of the superficial layers of the inner coat. It is a disease which is not, perhaps, of much importance when attacking the aorta or larger vessels; but when it affects the visceral arteries, it may lead to a considerable diminution of their calibre, to thrombosis, and thus to all those changes which ensue when the circulation becomes arrested. It is a change of this kind which Heubner lately described in the vessels of the brain as particularly liable to occur in the subjects of syphilis, and it is probable that a similar result may be induced in the larger arteries from the same cause.

2d. As a general affection of the arch of the aorta in which that vessel is grayish, softened, thinned, and dilated, but without any strictly atheromatous or calcareous change in it. It would be better, perhaps, to call this state "acute softening," though the nature of the process is essentially inflammatory.

3d. As a local disease in the arch of the aorta in cases of acute rheumatism. This is rare, sometimes originating in the friction produced by large valvular vegetations which are washed backward and forward in the blood stream, and sometimes without any such cause, and apparently as a spontaneous arteritis. In either case it is liable to lead to aneurism or imperfection of the aortic valves.

4th. As a local disease in the arteries secondary to the lodgment of emboli, which by their presence set up an arteritis.

Chronic arteritis may occur as a widespread and continuous disease in most of the arteries of the body or as one which is localized to various parts, specially the larger vessels. Of the former—a very rare disease—examples have been published by Wilks (*Guy's Rep.*, 1869) and Savory (*Med.-Chir. Trans.*, 1856). In Wilks's case the principal arteries of the body were thickened and obstructed, the vessels being filled with old clot that was "so closely adherent that the wall of the vessel would split rather than part from the clot. At both the ending and commencing parts the clot was white and like fibrous tissue and could not be distinguished from the coats, which here were swollen and atheromatous. The atheroma, indeed, appeared to be here in the clot also as well as in the arterial clot."

There seems little doubt also as to the fact that a vessel may become completely obstructed by a strictly local arteritis.

It may be noted in passing that the descriptions of the naked-eye appearances in these cases exactly correspond with that of the so-called syphilitic disease of the cerebral arteries just alluded to as having been described by Heubner, and which has been classed by us as acute arteritis, inasmuch as it is a disease purely cellular.

Such cases as the last, however, are rare compared with those of local chronic arteritis such as is met with in the arch of the aorta at its bifurcation and other parts. It is indicated by thickening of the vessel and loss of its elasticity, by the external coat changing into a tough fibrous tissue, and the affected parts, instead of feeling thin and pliable, becoming hard and leathery. "Now, such changes as these are commonly present along with the atheromatous pulp in the deep inner coat, and these are the part of the changes that go by the term 'atheroma' as commonly accepted. Changes of a kind that cannot be regarded as other than inflammatory are present in nearly all bad examples of

atheroma; the extent of the inflammatory changes generally surpasses that of the atheromatous, and these inflammatory changes occur often without any atheroma, and especially in younger subjects, about or under middle age. The more inflammatory changes tend more to produce aneurisms than do the atheromatous patches. When atheroma is thoroughly established, so that a pulpy mass is formed in the coats at any spot, this is generally thick and hard and unyielding, and does not give way to pressure so as to form an aneurism. The disease that leads to aneurism is the same disease as leads to atheroma, and I think it is a correct way of describing these relations to say that they are alternative results of the disease of the coats. I mean so that if the subinflammation is severer, then the coats are softened and yield early, before the thickening and stiffening chronic process that leads to the atheroma patch has had time to occur. On the other hand, if the subinflammation is lower and slower, then there is not such softening at any time in its course as to lead to aneurismal yielding; but the result is a slow thickening, which reaches a considerable and a sufficient degree before any fatty degeneration occurs within it, and then always the thickening goes farther than the granular change, so that the wall of the artery is rather stronger there than weaker; and if the subinflammation be yet slower and slower, the fatty or granular change in the coat goes on to an accumulation of lime salts or petrifaction of the spot, the stone in the wall showing sometimes some rude bone cells, so that ossification may be thought really to occur, though the bone is truly a very rough production, if it be bone at all. Now, if, instead of being thus slow, so as to give time for the calcareous change of its products, the subinflammation be very acute, then the arterial wall may rupture and either sudden death or a false aneurism be the result." "I might," adds Moxon, "give practically any number of cases and drawings showing the active cell formation in cases of atheroma, this cell formation found in the deep layer of the inner coat especially and causing the production of little nests of cells in which fat and lime soon accumulate. In severer cases the middle and outer coats and the deep layer of the inner coat are seen to be charged with lymph cells in enormous numbers, crowded together and separating the proper elastic and the muscular fibres into little patches and shreds, while both elastic and muscular fibres fall into a state of fatty degeneration" (Moxon, *Guy's Hosp. Rep.*, 1870–71).

In Figs. 142 and 143, taken from drawings kindly made for me by Dr. Moxon, these changes can be seen. His description is appended.

Dr. Moxon and others believe—and I think rightly—that mechanical strain is the main cause of atheroma of the arteries. It is chiefly found at points where the strain

FIG. 142.

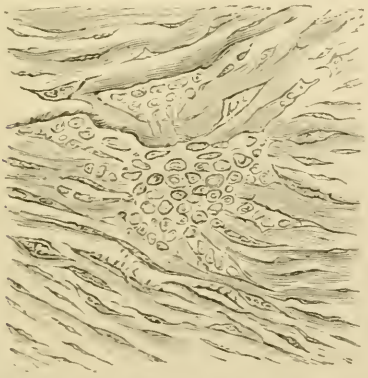


FIG. 143.

Fig. 142 shows the incipient inflammatory stage of the change in an artery which leads to atheroma, and in which aneurism usually occurs.

Fig. 143 shows the final degenerative stage of the same change in the artery which constitutes atheroma.

Fig. 142 is a small portion of a fine section of an artery from the neighborhood of an aneurism; the artery was here soft and swollen and had a more pellucid and bluish appearance than natural. A small and early patch of the disease is represented. The cells of the artery wall are found enlarged, their nuclei multiplied, and at the centre of the patch they burst toward each other to make a cluster of cells derived from the multiplied nuclei.

Fig. 143 is taken from the same artery at another spot, where the coat had the well-known yellow appearance of atheroma. Here the patch of multiplied cells has degenerated to a heap of oily and earthy matter with some plates of cholesterine. The individual cells around are seen to be degenerated in the same way. Some of those at the upper part of the figure are, on the other hand, developing into elastic fibrils. This is a frequent accompaniment of the atheromatous process, and its effect is to ultimately strengthen the arterial wall at the diseased spot.

upon the coats is greatest and in men who follow laborious occupations. Gulliver originally described it as a disease of the larger arteries, but it is now known to involve the whole arterial system.

In advanced disease calcareous plates are found in the larger arteries, while the smaller are converted into completely solid tubes. The vessels, moreover, alter in shape and become tuberous as well as tortuous, dilatation taking place at the points of bifurcation. When the disease is very extensive or advanced, the inner coats become destroyed and undermined with blood. When this undermining takes place to any extent, what is known as a *dissecting aneurism* may be produced; but in other cases the inner coat is so raised by the clot of blood behind it that the arterial canal becomes closed and gangrene of the parts supplied by the occluded vessel may ensue. In a preparation in Guy's Museum (1465) the aorta was thus affected, causing gangrene of the extremities. In others the vessel may rupture and cause death from hemorrhage. In rarer cases the vessel may be completely closed by the calcareous disease; in some the roughened raised patches become the centres of fibrinous adhesions which may either cause occlusion of the vessel directly by their size or indirectly by being carried into more distant arteries as emboli. In both cases gangrene of the parts thus deprived of blood will be produced. *Senile gangrene* doubtless is occasionally caused in this manner. Thus it is seen that this atheromatous disease of the arteries is often the cause of gangrene of a part by direct occlusion of the vessel as well as by embolism. As a general rule, however, in those instances in which portions of the artery are found to be withered and converted into fibrous cords, evidence is wanting of arteritis being the cause, recent investigations having tended to show that such changes are the natural result of an obstruction of the vessel, and that this obstruction is probably due to the plugging of a canal by a clot or to what is now known as an embolus.

Fatty degeneration of the inner and a primary calcareous change in the muscular or middle coat of medium-sized vessels must also be mentioned. These may be, and no doubt are, mostly associated with chronic inflammatory changes in the arterial system; but there is also reason to believe that sometimes they are essentially primary degenerations which lead to contraction of the vessels and senile gangrene, as do atheromatous changes.

Embolism

is a somewhat common affection, and consists in the occlusion of a vessel, large or small, by a plug of fibrin or calcareous matter carried by the blood from some diseased artery or distant part, and generally from the heart. The physician meets with it in cases of paralysis more or less complete associated with valvular disease of the heart, acute rheumatism, or aortic disease caused by a thrombus formed in an atheromatous vessel and carried forward into a cerebral vessel, or by the plugging of a capillary by the oily or fatty *débris* derived from the disintegration of an atheromatous patch. The surgeon meets with it in certain forms of amaurosis and local gangrene and as a precursor of aneurism. The pathologist sees it in the fibrinous clots (infarcta) found frequently in the lungs, spleen, kidneys, or other organs.

The symptoms of embolic occlusion of an artery are sudden and severe pain in the part from which the circulation is cut off, the pain in some cases extending down the whole course of the artery; in others it is a local numbness; tenderness is usually present in the course of the vessel. Symptoms of a deficient circulation in the part soon appear, such as coldness and pallor of the skin, which may go on to complete gangrene. All cases of embolic occlusion of an artery, however, do not end in death of the part, since in patients of good power the collateral circulation may become subsequently established and a recovery follow. In patients of feeble power gangrene is to be feared. In not a few cases embolism leads to the formation of an aneurism (*vide* page 357).

A woman æt. 47 who never had any illness was seized in June, 1868, with a mild attack of hemiplegia on the left side, from which she perfectly recovered in three weeks. She remained well and returned to her ordinary duties—those of a laundress—for three months, when, whilst kneeling, she suddenly felt a severe pain in the *right* leg, extending down the calf. This was rapidly followed by numbness and coldness of the leg and discoloration. She was admitted into Guy's under my care, three days subsequently, with gangrene of the foot and lower two-thirds of the leg. The pulsation in the femoral artery was normal, but no vessel could be felt below the thigh. I amputated the limb at the knee-joint on October 13, twisting the popliteal and other arteries. Some sloughing of the stump followed, but recovery appeared probable, when acute bronchitis set in, followed by delirium and death. Dr. Fagge kindly examined this patient's heart before the operation and reported: "There is scarcely any evidence of cardiac disease, but I think that I discover a short presystolic bruit. If this is so, the mitral orifice is probably con-

tracted; and a clot formed on the valve or in one of the heart's cavities may have been carried into the artery of the lower limb." After death the mitral was found the size of a button-hole. Around its edge were recent vegetations, and one of them, doubtless, had been carried into the circulation, causing the gangrene, as another had caused the paralysis three months previously.

Many cases of senile gangrene are doubtless embolic, from the washing away of some calcareous fragment from an atheromatous vessel.

In some cases of occlusion of an artery by an embolus, after the application of a ligature hyperæsthesia and increased temperature of the part below the seat of obstruction may be met with. These symptoms are clearly due to the influence of the nervous system and the congestion of the smaller collateral vessels.

Arterial Pyæmia.—Dr. Wilks has also shown (*Guy's Hosp. Rep.*, 1870) that as in phlebitis morbid matters may be taken up by a vein and carried into the circulation through the right side of the heart, thereby giving rise to *venous pyæmia*, so disintegrated fibrin of the blood may be carried into the arterial system from the left side of the heart and give rise to *arterial pyæmia*. Febrile symptoms with joint-pains and rigors associated with aortic and mitral bruit ought to excite suspicion of this latter affection; but when the liver or spleen is found enlarged, the diagnosis is confirmed. He also points out how this occurs in a secondary fever of the nature of pyæmia after scarlatina, which is often followed by joint-pains, and not unfrequently by endocarditis. In confirmation of these views I may mention that it has twice fallen to my lot, in the case of female patients aged respectively fifteen and twenty years, to amputate a leg for gangrene the result of occluded femoral artery after scarlet fever. In neither of these cases had any vessel to be secured, while in both a good result rapidly ensued.

Pulmonary embolism remains to be considered—a form which is important to the surgeon not so much as a disease of the lung as because it is generally a sequence of some clotting—or thrombosis, as it is called—in the veins. This clotting is very common in all kinds of cases under treatment in surgical wards. We can hardly represent the case too strongly, and we know of no more important subject than this relation of thrombosis to pulmonary embolism. Whenever a patient undergoes prolonged rest in bed, especially if he be naturally weak, bloodless, or debilitated from any cause whatever, if the blood be overfibrinous, as in lying-in women, whenever there is any surgical fever, and in other states too numerous to mention, there is a risk of clotting occurring in the *quiet* parts of the circulation, especially in the veins of the lower limbs and in those of the pelvis. The symptoms are often slight. If the clot be due to phlebitis, then there may be pain; if not, there may be no more than the slightest œdema about one ankle. This, however, is sufficient to put the surgeon on his guard, and by the subsequent enforcement of prolonged rest time is given for the adhesion of the plug to the vein wall, and pulmonary embolism is arrested. It should be remembered, too, that clot forming in contact with a comparatively healthy vein wall, as is the case in many instances, takes time, and sometimes a very long time, before adhering to the wall; and until it does there is the risk of its detachment when the patient moves. There can be no doubt that many have died of pulmonary embolism when with a little more vigilance on the part of the attendants they might have been saved.

These remarks apply to embolism of the larger branches of the pulmonary arteries, which never give rise to further changes in the lungs, and the patient dies from asphyxia. If the smaller branches, however, become plugged, then arise those secondary infarcta already mentioned, and in the case of septic embolism the lobular pneumonia of pyæmia and gangrene of the lung.

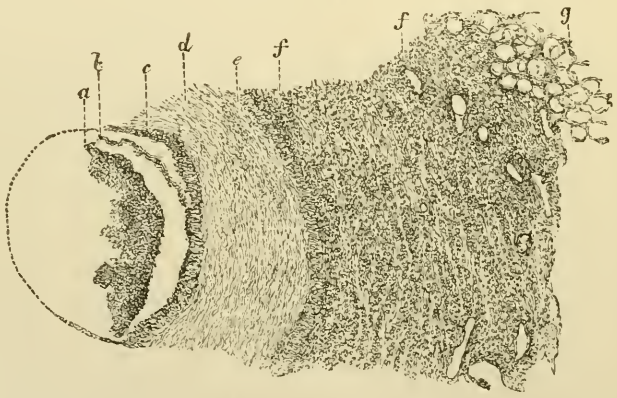
Pathology.—The changes which take place when an artery becomes plugged differ according to the size of the affected vessel. If it be a *terminal* vessel, the immediate result is congestion of the vascular area concerned, with subsequent hemorrhage and atrophy of the tissue. The various stages may be studied with great precision by the ophthalmoscope in occasional cases of embolism of the arteria centralis retinæ. It is unnecessary to discuss whether the process is due to vasomotor paralysis or alteration of blood pressure, since it is of pathological rather than of surgical interest, and the questions involved are fully stated in all pathological works. We shall, therefore, only remark further that embolism of the small vessels is important or otherwise according as the source from whence the plug is derived is healthy or not. If the clot be septic, then the resulting infection will probably lead to an abscess: and hence the probable connection of abscesses in the pelvis with those in other parts after labor or after operations in the viscera or connective tissue of the body. But embolism of the medium size and larger

arteries is followed by changes of the very greatest moment in the walls of the affected vessels. Unfortunately, they have up to the present time not been fully worked out as regards embolism, though we can obtain considerable aid toward understanding what takes place by availing ourselves of the experiments which have been made for us by the ligature of vessels. When an artery of any size becomes closed by an embolism, the canal may, of course, be gradually restored by the disintegration and washing away of the plug; if not, the presence of the clot acts as an irritant, inflammation is set up, and the clot becomes adherent to the wall of the vessel. It is a disputed point whether the next stage is one of organization and vascularization of the clot, or of absorption of the clot by vascular granulations which spring up from the wall of the vessel. Weber holds the former, but Cornil and Ranvier the latter, view. This difference, however, does not matter, as all that is important would be granted by either—viz., that embolism leads sooner or later to a local inflammation of the arterial walls. But if arteritis is thus produced by a simple and healthy clot, the intensity of the local disease will be greater when the clot is septic, the plugs so exciting the component elements of the surrounding arterial coat that its tissues will become disorganized, its cellular elements multiply rapidly, and the coats, as a consequence, give way. Indeed, we know that these changes do actually occur in small vessels and abscesses follow; so, without doubt, also—though the fact is less generally recognized—the same changes occur in the larger arteries and lead occasionally to aneurism. I shall revert to this subject in the chapter on "Aneurism," and will add no more here, since what has been already said, together with the subjoined woodcut of the state of the arterial coats after embolism, may sufficiently explain the morbid processes set up in the larger vessels.

Treatment.—The objects which surgeons should have in view in the treatment of a vessel occluded by an embolus are to favor the venous circulation through the limb by its elevation and to establish the arterial collateral circulation by maintaining the warmth of the limb by means of cotton-wool carefully wrapped round it over oiled lint. Pain can be relieved by sedatives, such as chloral or opium, given by the mouth, or morphia injected subcutaneously, while the powers of the patient are to be maintained by nutritious diet, by stimulants carefully administered, and by tonics.

When gangrene has taken place, the parts may be covered with some antiseptic material, as carbolic acid in a watery or oily solution, one part to thirty, or with powdered

Fig. 144.



Transverse Section of the Upper Part of the Radial Artery plugged by an Embolus of Septic Origin some Days before Death. (From a case of ulcerative endocarditis, boy æt. 19. Drawn by Dr. J. F. Goodhart, to show the condition of the adventitia.)

a, Clot.
b, Internal coat.
c, Internal elastic or fenestrated membrane.
d, Middle muscular coat.
e, Outer elastic membrane.
f, Adventitia crowded with abnormal nuclei and proportionately thickened.
f', Region of vasa vasorum.
g, Fat.

charcoal, chloralum, terebene, or MacDougal's disinfecting powder; but if the odor is not very offensive, simple oakum surrounding the part may be sufficient.

When the line of demarcation has formed and the gangrenous part can be removed by amputation, such an operation may be performed; but the surgeon should always be cautious in interfering with these cases. He should at the same time take every precaution that any necessary or desirable operation is not unduly postponed.

ANEURISM.

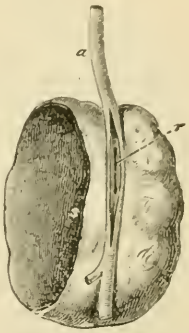
An aneurism is either a *sacculated tumor* containing blood communicating with the canal of an artery and formed more or less from its walls, or a *fusiform dilatation* of an artery. When all the coats are involved in the sacculated dilatation, it has been the custom to describe it as being *true;* and when the two inner coats have given way and the external or cellular alone remains, as *false*. I agree with Holmes, however, that it is impossible clinically to perceive any difference between true and false aneurisms at the time they generally come under observation, inasmuch as the true become false as they grow and the false are by far the more common. I hold, moreover, with Moxon, that pathologically, "when an aneurism has reached any size, and often before it has well started, the several coats of the vessel have lost by inflammation their distinctive character, and that the sooner the division of aneurisms into varieties by the supposed behavior of the several coats becomes purely a matter of history the better."

When the distension of a vessel involves its whole calibre, a *fusiform or tubular aneurism* or aneurismal dilatation is said to exist, whether the enlargement be or be not due to an inflammatory disease of the arterial coats.

What is described as a *diffused, spurious, or consecutive* aneurism is where the sac of the aneurism is formed by the muscles and condensed cellular tissue of the part into which the blood has been extravasated from a ruptured aneurism or a ruptured artery rather than by the arterial coats. These terms should not be applied to cases in which there is *diffused extravasation* of blood.

A *dissecting aneurism* is one in which the inner is separated from the middle coat, or where blood is extravasated into the thickness of the middle coat itself or between the middle and external coats, the blood re-entering the cavity of the artery at some distant spot. The aorta is the part usually affected, and even its whole length may be involved. An excellent example of this affection has been recorded by Dr. Fagge (*Med.-Chir. Trans.*, vol. lii.). These cases, however, rarely come under the hands of the surgeon. There are also cirsoid and arterio-venous aneurisms, to which attention will be drawn. To show what an aneurism may do, the following figure (Fig. 146) is given. It was taken from a drawing in Guy's Hospital Museum. The aneurism of the innominata has involved the left carotid and root of the subclavian, a second aneurism of the left carotid existing above.

FIG. 145.



Sacculated Traumatic Aneurism. (Drawing 4418, Guy's Hosp. Mus., Mr. Poland's case.)

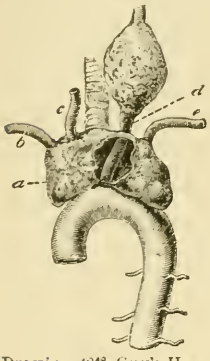
PATHOLOGY OF ANEURISM.

A low form of inflammation of the arterial walls is, without doubt, the most common predisposing cause, while overaction of the heart and circulation is the exciting cause of aneurism. Direct injury to an artery is an occasional cause (traumatic), although more frequently the injury sets up the disease that produces the aneurism. Whenever the coats of an artery are weakened by accident, disease (suppurative or otherwise), or the loss of their natural support, they become liable to dilate under any sudden or prolonged increase in the force of the circulation. Dr. Rendle of the Queen's Prison, Brixton, has recorded two cases in which abdominal aneurism could be traced to the shock caused by a sentence of transportation. Aneurisms are more common in the aorta, where chronic inflammatory changes are so likely to appear and the heart's action is more directly felt: at the bifurcation of an artery, where the force of the circulation is always more powerful; or at the flexure of joints, where muscular action is the most liable to tell by overstretching or bending.

That aneurism is a disease of the arterial system and not always of traumatic origin is proved from the fact that a man may have an aneurism form when in bed and that the whole arterial system may be involved in the disease. Broca has mentioned a case of Pelletan's in which sixty-three aneurisms were found in one body. It is also a disease of middle age, half the cases occurring between the ages of thirty and forty-five. It is not uncommon, however, to find it in young persons. Dr. N. Moore exhibited one of the external iliac artery in a child æt. 7 (Path. Soc., October 17, 1882). Syme has recorded an instance in a child of nine. My colleague, Dr. Habershon, reported an example of femoral aneurism in a boy of ten with heart disease. *Cerebral* aneurism in early life is still more common. But such cases, almost without exception, are associated with vege-

tations on the valves of the heart, and often with ulceration of the valves, and are probably due to embolism. The symptoms are those which Dr. Wilks has described under the term "arterial pyæmia;" they are, mainly, considerable pyrexia and enlargement of the spleen. Many such are now on record, and, besides the parts above mentioned, they have been found situated on the brachial, ulnar, popliteal, axillary, mesenteric, and many other smaller vessels. Indeed, the frequency of their occurrence can only be estimated by looking into the literature of visceral aneurisms. It will then be found that, though the relation between heart disease and aneurism has not till of late years been studied, very many cases of aneurism associated with endocarditis and emboli in the solid viscera have been recorded at different times. Among the earliest writers on the subject are Joliffe Tufnell in the *Dublin Journal*, vol. xv. p. 371; Dr. Ogle, *Path. Trans.*, vol. viii.; Dr. Wilks, do., vol. xi.; Mr. Holmes, do., vol. xii. Other cases have been recorded in the same *Transactions* more recently by Drs. Church, Goodhart, Gowers, Murchison, Semple, and myself. Similar cases may also be found in various medical publications (*vide Bright's Medical Reports*, vol. ii. p. 266; Gull, *Guy's Hosp. Rep.*, 3d series, vol. v. p. 299; Ponfick, *Virch. Archiv*, Bd. 58, 1873. See also Wilks and Moxon, *Path. Anat.*, pp. 158, 159; Holmes, *Syst. Surg.*, etc.).

Fig. 146.



Drawing 42⁴⁸, Guy's Hosp. Mus.

Various explanations have been given of the occurrence of aneurism under such conditions. It has been maintained by some that the plug leads to sudden obstruction and afterward to dilatation of the vessel behind it. But a look at preparations of such aneurisms shows that the dilatation is not behind the embolus, but actually at the plugged spot. Moreover, if the local obstruction leads to dilatation behind it, we ought to find aneurism a more common result of ligature than is the fact; we ought to find it more frequently after embolism than we do, because embolism is a very common affection in one part or another of the body. Other ingenious though somewhat labored explanations have been offered, which need not be mentioned here; and the only one of any importance is that recently ably argued by Dr. Goodhart, attributing the aneurism to a local arteritis which in its turn has been caused by the embolism. It has been already asserted that when an artery becomes blocked, the clot, unless it softens and breaks down, becomes adherent to the wall and subsequently becomes vascular. If this be true—and that it is so is allowed by nearly all observers—then there must have been some preceding inflammation of the wall of the vessel to allow of this new formation of capillaries. That embolism causes a local arteritis is admitted, but how it is that under these circumstances an aneurism is so rare a result has yet to be explained, and the explanation is probably to be found in an examination of the cases in which emboli exist. They are, almost without exception, examples of ulcerative endocarditis in which there is a very severe local inflammation attended with symptoms of blood poisoning which is supposed—and we think rightly so—to be due to the septic nature of the emboli which are detached from the ulcer and carried to all parts of the body. When this septic clot becomes lodged in some part of an artery, in proportion to its septicity the artery will inflame, and as a consequence, in the more severe cases, there will be the rapid formation of an abscess and perhaps a false aneurism, whilst in those somewhat less severe cases there will be acute softening and cellular infiltration of the arterial coats, with probably the formation of a true aneurism. In the majority of cases, however, as the embolism is not caused by septic clots, there will be neither aneurism nor abscess.

In June, 1883, through the kindness of my colleague, Dr. Pye-Smith, I saw a man æt. 25 who had been admitted under his care at Guy's with heart disease and symptoms of embolism of the spleen, kidney, and right brachial artery at its bifurcation. The arterial obstruction had taken place the day before his admission, when he was at work, with sudden severe throbbing pain in the bend of the elbow, soon followed by swelling. On admission there was a local swelling at the point corresponding to the bifurcation of the vessel, pulsation in the brachial artery down to this spot, but not at it, no pulsation in the right ulnar artery, and very feeble pulsation in the radial. On the second day a hard lump was felt at the bifurcation of the brachial. On the fourth day the pulsation in the lower vessels had improved. On the sixth the collateral vessels about the elbow were enlarged. On the thirtieth day where the lump had been at the bifurcation of the brachial artery strong pulsation was felt. On the thirty-fourth day an aneurismal sac was clearly to be felt, with a marked bruit over it. On the forty-sixth it was as large as

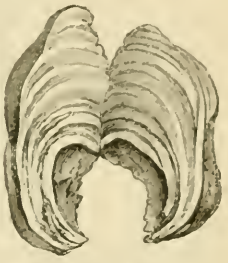
a nut. The pulsations in the radicle ulnar arteries were full. In this case the whole course of events may be said to have been under observation, and the fact of the formation of an aneurism following an embolism was clearly demonstrated.

Progress and Natural Cure of Aneurism.

An aneurism, when once formed, has a natural tendency to increase—the "sacculated" more so than the "fusiform;" and the "sacculated" communicating by a small opening with the cavity of an artery has a tendency to increase more rapidly than another in which the opening is free, the force of the circulation being more concentrated upon one point of the aneurismal sac in the former case than in the latter. Hence sacculated aneurisms attain a much larger size than the fusiform, and are much more liable to rupture.

When an aneurism is cured, it is so by its cavity becoming filled with blood clot, which subsequently contracts, and in the best cases by the occlusion of the arterial trunk upon which the aneurism is placed; the sacculated aneurism is more capable of a natural cure than the fusiform. When the arterial coats are roughened by disease and weakened, the fusiform is as likely to increase as the sacculated and is as capable of a spontaneous cure. In any case of sacculated aneurism, as well as in some of fusiform, a *spontaneous cure* may take place by the coagulation of the blood in the sac and the subsequent consolidation of the clot. When this process is slow, the fibrin of the blood is deposited in layers or laminæ (Fig. 147); the external layer in contact with the walls of the sac becomes at times more or less united with them, and so strengthens them as to prevent their dilatation; the clot also becomes dense by contraction and decolorized. Subsequent layers form in the same manner as the process of recovery proceeds, until the whole sac is filled and finally obliterated. A section of an aneurismal sac thus cured much resembles that of an onion, the outer laminæ of fibrin being thin, fibrous, firm, and bloodless, each successive layer toward the centre approaching more to the color and consistency of newly-coagulated blood. The laminated coagulum lining the sac is frequently called, after Broca, "active clot," and the soft coagulum in the centre "passive clot," from the idea that this latter is a mere post-mortem and not a vital deposit. This view, however, can scarcely be correct, as there can be little doubt that in all cases of aneurism that are rapidly cured by pressure, digital or otherwise, the consolidation of the aneurism must be due to the simple coagulation of the blood in the sac and its subsequent induration and contraction, inasmuch as a few hours are evidently too short a period for the coagulum to form in any other way. In the following beautiful drawing (Fig. 148) by Dr. Moxon, taken from a specimen of popliteal aneurism, which was cured, in a man under my care two years before death, by digital compression applied for four and a half hours (see *Guy's Hosp. Rep.*, 1869), the whole pathology of aneurism is shown, with the consolidation of the aneurism and occlusion of its supplying artery.

Fig. 147.



Laminated Coagulum removed from Axillary Aneurism twelve years after Mr. Kay had ligatured the Subclavian Artery. (Operation performed 1823. The coagulum had no attachments to the sac. Prep. Guy's Hosp. Mus., 14996.)

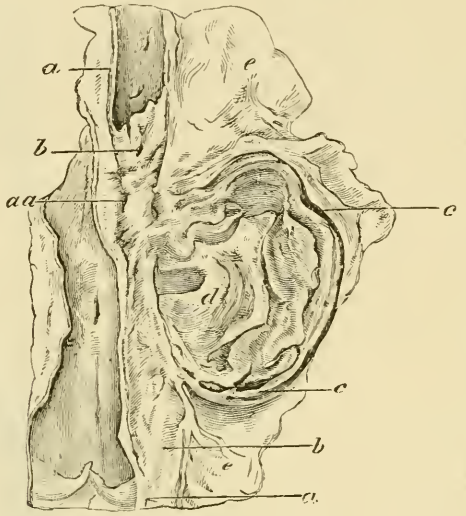
Colles of Dublin, and some older pathologists, believed that the fibrin which lines the sac was the product of an exudation from the lining membrane of the sac, and that successive exudation of this material formed the laminæ. This view, however, is now almost exploded. Le Fort also accounts for the cure of the fusiform aneurism by inflammation of the inner lining of the sac, and he regards the fusiform as a simple dilatation, which it is not in all cases. Most pathologists, however, now admit that where the inner tunic of an artery exists in a healthy state in an aneurism, coagulation of the blood does *not* take place within the sac, and consequently that a spontaneous cure is impossible, and that in the sacculated or fusiform aneurism successive deposits of fibrinous laminæ only take place when the internal membrane is absent, from the contact of the blood with the rough walls of the sac.

Mr. Poland has recorded a case, probably unique, occurring in the practice of Dr. Adams of Dublin, of fusiform aneurism of the subclavian, which tends to support this theory (*Med.-Chir. Trans.*, vol. lii. 1869).

An aneurism may also be cured by the "distal occlusion" or plugging of the artery beyond the sac with a clot that has been dislodged by the force of the circulation, accident, or design. The vessel at first may be only partially closed by the clot, yet fresh

fibrin will soon be deposited upon the "embolic plug" and complete obstruction be produced. This natural mode of cure is utilized in the distal operation for the cure of aneurism, and in the cure by manipulation. Recovery may also be caused by the "sloughing of the tumor" (suggesting the treatment by caustics). It is likewise on

FIG. 148.



a, The section edge of the arterial coats where healthy.

aa, The coats in the diseased and occluded part of the artery. Their substance is dispersed and blended with the new fibrous tissue, *b*, which fills the vessel, yet not so much diffused but that they can still be traced to the mouth of the aneurism (opposite the upper *c*).

c, The aneurism sac, composed of laminated clot and compressed tissue welded together indefinitely.

d, Scarcely laminated clot, filling the hollow of the sac.

The vein, with two valves in its lower part, is seen close behind the artery.

Section through an Aneurism of the Popliteal Artery, cured nearly two years before by Digital Pressure. (The aneurism is not dissected out, but left embedded in the popliteal fat, *e*, *e*. The artery is occluded with the aneurism.)

record that the artery with which the aneurism is connected may be obstructed either above or below the sat by the pressure of the aneurism itself, from its being bound down by a strong fascia or from the pressure caused by effused blood following its rupture, and in the treatment by flexion this natural mode of cure is made use of. As an aneurism increases and encroaches on the neighboring parts, tissues are separated, and even absorbed; bone may even be gradually worn away by the steady pressure of the pulsating tumor, so that in thoracic aneurism the sternum may be perforated or the bodies of the vertebræ eaten away and the spinal canal opened (Prep. 1489[30], Guy's Hosp. Mus.). During this increase the tissues surrounding the sac may inflame, though they rarely suppurate, and by becoming condensed give the aneurism some support and tend to retard its growth. In rare cases this inflammatory action may involve the sac itself and cause sloughing; but when the aneurism increases unchecked, it will eventually give way. A thoracic or abdominal aneurism may burst into a mucous tract such as the trachea, pharynx, œsophagus, or intestine; and, when it does, Dr. Gairdner (*Med.-Chir. Trans.*, vol. xlii.) has shown that it proves fatal by a recurrent hemorrhage through a *small* orifice. When it bursts into a serous cavity, such as the pleura, pericardium, or peritoneum, it destroys by a sudden hemorrhage through a *large* aperture. Cases are also on record where it discharged itself into a vein or the pulmonary artery. External or surgical aneurisms burst by the formation and giving way of a slough. Aneurism of the extremities, or surgical aneurism, may give way into a joint or cellular tissue. It may burst externally, but only in rare instances. An aneurism may be fairly filled with clot and yet increase, the blood making its way round the clot and thus dilating its walls. This is prevented only when the artery connected with the sac as well as the aneurism is filled with clot.

The surgeon, however, has more to do with external than internal aneurisms, and, although the pathology of both forms is alike, the treatment differs. It is to surgical aneurisms, therefore, that the following remarks may specially apply, and first of all as to their symptoms and diagnosis.

SYMPTOMS AND DIAGNOSIS.

An aneurism has no pathognomonic symptoms, and its early symptoms are very uncertain. It often happens that the patient's attention is first directed to some *swelling*,

although it may be only that of *local throbbing*—some weakness or stiffness of an extremity, or some *nerve pain* preceding the discovery of the disease; yet such symptoms are not constant. When, however, the surgeon is consulted for pain that shoots down the course of a nerve running in contact with a large artery, he should allow the thought of aneurismal pressure to pass through his mind; and when this is associated with the presence of a tumor connected with the vessel, the suspicion of its being aneurismal should be excited. If this tumor be *soft*, *expansile*, and *pulsating*, if it become tense on the application of pressure to the trunk of the artery on the distal side and flaccid, non-pulsatile, and vanishing on pressure on the cardiac side, and should pressure on the tumor modify the pulse in the vessel below, the chances of its being aneurismal amount almost to certainty. Should it expand again readily on the removal of the pressure, and this expansion be accompanied with a peculiar thrill on the readmission of blood into the sac, with a bellows murmur or aneurismal bruit synchronous with the pulse—audible, too, on the application of the ear to the tumor—the diagnosis is complete.

The pulse of the extremity below the swelling is generally affected; it is weaker and slower than its fellow, and as the disease progresses it may cease altogether. The blood will then flow in a "venous stream" or cease to flow, either from the obstruction of the arterial trunk by the pressure of the aneurism or the embolic occlusion of the vessel below from a dislodged coagulum. Under these circumstances, fulness of the veins with œdema of the parts supplied by the artery will soon appear, and at times excruciating pain from stretching of the nerves will arise. If the aneurism be cervical and the circulation through the brain be interfered with, giddiness and loss of consciousness may be present; and where any pressure is made upon the recurrent laryngeal nerve, a peculiar and characteristic hoarseness will be produced. This hoarseness is sometimes associated with loss of voice and laryngeal spasms simulating laryngeal disease. In the case of a women æt. 22 under my care, in whom an aneurism existed involving the aorta below the opening of the left subclavian and pressing upon the left bronchus and trachea, this symptom was so severe as to call for tracheotomy. When the cervical sympathetic ganglia are pressed upon, the pupil of the affected side may be permanently contracted, and nerve pains will be present according to the amount of pressure applied.

When an aneurism has partially consolidated and has either so enlarged or become so diffused as to press upon the soft parts, so as no longer to exhibit any pulsation—for there are aneurisms that do not pulsate—when it feels firm, with possibly a soft point here and there, some difficulty may be felt in forming a diagnosis, and the surgeon, under these circumstances, will have to depend as much upon the history of the case as upon the physical symptoms. When external signs of inflammation or suppuration are present, the difficulty will be enhanced; for it must be recorded that aneurisms, under these circumstances, have been opened for abscesses. I remember a popliteal aneurism having been so maltreated with a fatal result. Such mistakes of diagnosis, however, ought not to occur, as they are due to carelessness. The diagnosis of an aneurism may generally be made by attending to the history of the case and to the existing symptoms. An abscess in contact with an artery may receive pulsation from it, as may any cyst, or even solid tumor; but in all these the pulsation will cease on the application of pressure to the artery above the tumor without any change whatever taking place in the tumor itself. I have seen a case of lumbar abscess which pulsated freely from aortic contact. It is also rare for such tumors to cause a bruit. Cases are on record in which an artery in contact with an abscess or suppurating hydatid cyst has been opened by ulceration and given rise to the idea of an aneurism. Pulsatile tumors of bone may also be mistaken for aneurism, but from the former being in bone and more or less ossific, from the bone being expanded—although, perhaps, irregularly—and from a bruit rarely existing in it, the diagnosis ought not to be difficult. Tumors lying near large arteries and receiving pulsation from them may likewise be mistaken for aneurism, but, from the pulsation not being expansile and the tumor being capable of being drawn away from the vessel, a correct diagnosis should be made. It must be admitted, notwithstanding, that men of the greatest skill and experience have mistaken such cases for aneurism.

Treatment.

There is probably no disease a surgeon has to treat which requires to be dealt with more on scientific principles than aneurism, since all treatment, to be effective, must be based upon the physiological processes of a natural cure; and this natural cure is brought about by the coagulation and subsequent consolidation of the blood in the aneurismal sac, and in the best examples in the artery upon which the sac is placed (*vide* Fig. 148).

To induce coagulation of the blood in the sac and artery by natural processes becomes, consequently, the chief object of treatment, and this is to be brought about by general as well as local means. For this purpose it is necessary to have a feeble circulation through the sac; and to this end *rest in the recumbent position is an essential point to be observed*, and it ought to be maintained in every case; indeed, there is every reason to believe that by it alone aneurisms have been cured. Luke (*Lond. Med. Gaz.*, May, 1845), Bellingham, Tufnell, Stanley (*Path. Soc. Trans.*, vol. v. p. 107), and others have recorded instances of this nature. Tufnell allowing for diet about ten ounces of solid and eight ounces of fluid food in the twenty-four hours. *As a preliminary to all other treatment, "absolute rest" is, therefore, most essential.*

With the same object "bleeding" has been employed, and was at one time largely practised on the authority of Valsalva, who powerfully advocated it, and probably to excess. There seems no reason why it should not be adopted when the force of the circulation is strong and the powers of the patient are good, as bleeding not only lowers the force of the circulation, but at the same time tends to render the blood more fibrinous. In internal aneurism it is calculated to be of more service than in external, but, practised with caution, it is doubtless of value in both. Medicines do not seem to have much influence in encouraging the coagulating process, though the acetate of lead gave some promise of value in the hands of my former colleague, Dr. G. O. Rees, but more extended experience has not confirmed the hope held out; the iodide of potassium or sodium has been also much vaunted, more particularly when syphilis is suspected. *Nutritious*, but *unstimulating*, food should be given in all instances to maintain the powers of the patient, though not to increase the force of the circulation. All mental excitement should be positively forbidden.

The object of the local treatment of aneurism is to arrest or diminish the circulation through the sac, and the success which is to be expected from whatever practice may be adopted will depend as much upon the shape of the aneurism as upon the size and position of the opening into the sac. The surgeon has for this purpose a variety of means at his disposal, which may be divided as follows:

1. Compression of the artery above the aneurism—"indirect pressure."
2. Compression of the aneurism itself—"direct pressure."
3. Compression of the artery as it leaves the aneurism—"distal pressure."
4. The Hunterian operation of applying a ligature to the artery on the cardiac side of the aneurism or the occlusion of the afferent vessels by other means.
5. The application of a ligature to the artery within the aneurism itself—operation operation of Antyllus.
6. The application of a ligature to the artery on the distal side of the aneurism—"distal operation."

There are likewise other means which may be justifiably employed in exceptional cases—such as the treatment by manipulation, galvanic puncture, and the introduction of some foreign body into the sac—to which attention will be drawn. At Guy's Hospital in the fifteen years ending 1880, 42 aneurisms were treated by compression alone, and 19 by the Hunterian operation when compression had failed. In 13 cases the Hunterian operation was primarily employed. In 3 the operation of Antyllus was performed. In 3 the distal ligature was used. In 1 primary amputation was called for, and in 1 the aneurismal sac was plugged with horsehair. In all, 82 cases were treated. For full details *vide* valuable paper by Charles Symonds (*Guy's Rep.*, vol. xxv., 1881, p. 447).

Treatment by Compression.

1. Indirect Pressure.—This plan of treatment, to which the term "Dublin method" may fairly be given, has now found a lasting place in surgery: Todd, Hutton, Bellingham, Tufnell, and Carte, though not originating the practice, having adduced ample evidence of its scientific and practical value. It consists essentially in the more or less complete cutting off the supply of blood from the aneurismal sac by the application of pressure to the artery on its cardiac side; and the more completely the current of the blood is arrested, the more rapid appears to be the cure, modern experience having fairly proved the soundness of Dr. W. Murray's observation in 1871, that the principle on which the rapid method rests is clearly "the complete stagnation of a mass of blood in the aneurism until it coagulates." Whether this is to be done under the influence of an anæsthetic or without, whether by pressure both above and below or only above the sac, and whether the pressure is to be made by the hand, by flexion, by a weight, or by a

tourniquet, are questions which in no way touch the principle on which the treatment is based. The practice is theoretically sound and practically safe, and is capable by itself of curing the majority of surgical aneurisms, and even some that are internal. At least four cases of aneurism of the neck have been cured by digital compression of the common carotid, and M. Rouge of Lausanne reports a fifth, in which a man æt. 68 had a carotid aneurism cured in seventeen days by lateral pressure between the thumb, in front of the sterno-mastoid muscle, and the fingers behind (*Bull. de la Soc. de Chir.*, 1868, p. 464). Mr. Gay has also apparently cured a sixth case by the same process (*Lancet*, Holmes's lect., 1873).

Compression should not be attempted where evidence exists of pressure upon the main vein of the limb, as indicated by œdema, or where the aneurism is rapidly increasing or a rupture of the aneurism appears imminent, because in such cases a ligature should be applied to the arterial trunk. It should not be persevered with when sloughing of the skin has been induced, nor ought it when, from some constitutional irritability, indocility, or stupidity, the patient fails to second the surgeon's aim; for to make the patient understand the objects which the surgeon has in view is doubtless a valuable means of guaranteeing their successful accomplishment. It must be known, however, that when compression has failed to cure, "the patient is in a worse, and not a better, state for subsequent operation." Mr. Holmes has demonstrated this fact (*Lancet*, October 12, 1874).

This treatment can be carried out by "digital" or "instrumental" compression or by means of "Esmarch's bandage," a form of pressure which differs from the other in some essential points, to which attention will be drawn.

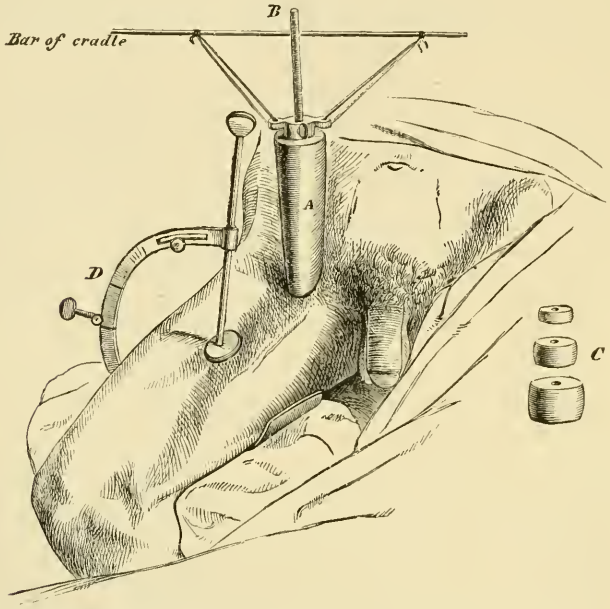
Digital pressure, to be successful, must be well applied; when indifferently carried out, it is probably less to be relied upon than instrumental pressure. To keep up a steady pressure upon the trunk of an artery for any time consecutively is a difficult task, and few men could do it for more than ten minutes. What is wanted is the steady equal pressure of a finger or thumb applied directly over the vessel which is to be compressed, such pressure being so adjusted as to be sufficient to arrest the flow of blood through the artery, but no more. Greater pressure than this is a waste of power on the part of the surgeon and a cause of needless distress to the patient. Neither vein nor nerve need be much pressed upon, as a rule, nor much pain produced. To carry out this treatment three good men should be employed for four or five hours consecutively, each in rotation carefully applying pressure for ten minutes at a time. By adopting this practice I have cured an aneurism of the thigh in twenty-four hours, and in other cases even less time has sufficed. In a case I recorded in *Guy's Hosp. Rep.* for 1869 a patient æt. 32 cured himself of a popliteal aneurism by pressure in four and a half hours. In one more recent a man æt. 40 cured himself in eighteen hours, after flexion and prolonged surgical treatment by instrumental pressure had utterly failed. M. Vanzetti in 1855 records a case in which digital compression cured a popliteal aneurism in four hours.

When digital pressure can be employed and is successful, it is more rapid than any other, and, as a rule, less painful. It can also be used where instrumental pressure is inapplicable, as in the case of the carotid. In fact, when admissible, it should always be primarily employed in preference to any other form of treatment.

Instrumental Compression. — *When digital compression cannot be applied, the next best is instrumental pressure*, and for this purpose there is nothing equal to a conical weight of lead (Fig. 149, A) covered with leather and perforated with an iron axle (B), upon which extra pieces of lead (C) can be dropped (Bellingham's method), the weights being so adjusted as to arrest the circulation through the artery, and no more. This weight can be slung to a cradle placed over the limb, held by an assistant or left to the intelligent patient. It can be shifted gently from one spot to another when pressure causes pain, and is far less painful than any other instrument. In popliteal aneurism the weight may be adjusted to the upper part of the groin, and it is an excellent plan to apply a semicircular tourniquet lower down, by which means pressure can be applied alternately. The instruments of Signorini, Bellingham (Fig. 149, D), Skey, Crampton, Carte, or any other that allows the pad to press upon the vessel and not otherwise interfere with the circulation through the limb, may be used for this purpose. All of these consist of a circle or semicircle of steel, a fixed pad being attached on one side for counter-pressure, and a movable pad, adjusted by a screw, for direct pressure. Indeed, with these instruments carefully adjusted by the aid of a trustworthy assistant who will see that pressure is well applied, maintained, and shifted only when required, most cases of aneurism of an extremity may be treated. In Fig. 150 is depicted an ingenious contrivance made by Weiss, on

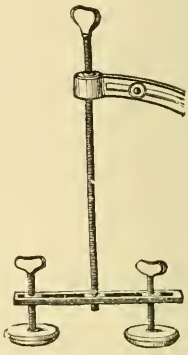
the principle suggested by Mr. F. Bulley, for the application of pressure to an artery by means of pads which may be used alternately and adapted to Bellingham's instrument (D, Fig. 149), either by the rigid screw or elastic pressure of Coles's pad; and in Fig. 151 is shown a very valuable arrangement suggested by Mr. George C. Coles—the pressure being

FIG. 149.



Mode of applying Pressure to the Femoral Artery for the Cure of Aneurism.

FIG. 150.



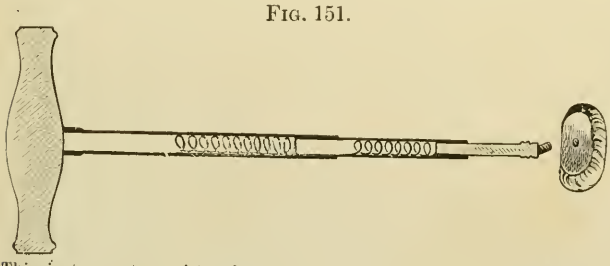
Weiss's Double Pad.

elastic—which may be used as hand pressure or adapted to any of the tourniquets. The treatment by compression requires intelligent supervision, and then is very successful, but without such it is uncertain in its effects.

My friend and colleague, Mr. Davies-Colley, who happened to have been my dresser when a case of popliteal aneurism was under treatment by digital compression, informed me that he proved by experiment that he could readily arrest the circulation through the femoral artery for six or eight hours at a time with his finger applied directly over the vessel and the weight adjusted upon his finger, the weight acting in lieu of the muscular power that would otherwise have been required as the compressing force.

To neutralize the effects of the local irritation of the skin by the pressure, free use may be made of French chalk, starch, or violet powder. To allay pain opiates or chloral in full doses may be given, and in some cases even chloroform may be used and its influence kept up for several hours, to allow of complete compression being maintained. Dr. Mapother did this for twelve hours. There seems little doubt that in a general way complete obstruction to the circulation is more likely to be followed by a rapid cure than is incomplete, and that next to completely stopping the flow of blood till the aneurism has consolidated the application of the intermittent complete compressing force is to be advocated, or, in other words, complete compression may be maintained for a certain time and then given up, to be returned to as soon as the condition of the patient will permit. The total suppression of the circulation is doubtless the most rapid plan of curing an aneurism, but

FIG. 151.



This instrument consists of a trephine handle, to which is attached a straight rod telescopically arranged. The two upper segments of this rod are hollow tubes, each containing a spiral spring; the lower segment is a solid brass rod fitting into the upper, having at its extremity a screw at an obtuse angle. To the end of this is adjusted a pad composed of cotton-wool and horsehair.

the partial suppression is likewise successful, although slower. On all these points, however, I should like the Dublin surgeons to speak. Dr. Rawdon Macnamara has done so in an able paper (*Brit. Med. Jour.*, August 19, 1871), from which the following extract has been taken. It epitomizes the whole:

"A case of popliteal aneurism presents itself for treatment. We determine to use compression. We first carefully ascertain the condition of the patient's general health. If anæmic or hyperæmic, we take appropriate measures; and when we are satisfied upon this point, we apply some one or other of the most improved compressors—those in which the compressing power is modified elasticity. With this we compress the artery in the upper portion of its course, having previously arranged, some three or four inches lower down, the auxiliary instrument by means of which we propose to alternate the pressure. The upper instrument is now made to control the artery, so as but just to arrest the pulsation in the sac. This is the most delicate step in all the procedure, and is regulated by the hand of an intelligent assistant, who at once informs us when the pulsation is arrested; and then and there the further application of pressure is arrested. A roster of intelligent students is now organized, and to them is entrusted the management of the case. Two are appointed to take charge of the patient for one hour, when they are relieved by two others, and so on during the day, whereby we secure unwearied attention during the period that pressure is kept up; and, as in Dublin we visit our hospital at 9 o'clock A. M., the treatment generally commences about that hour and is continued up to nine o'clock P. M., when all pressure is removed and the patient is encouraged to take his night's rest undisturbed. Next morning the treatment is resumed, and so on until the cure is perfected. At the commencement of the case we take the patient into our confidence, explain to him the nature of his case and the method we are about to adopt for his cure, placing clearly before him the alternative, with all its possible dangers, which we should have to adopt in case compression should fail. The value of this procedure is very frequently demonstrated by the intelligent interest exhibited by our patients in the management of their own cases—so intelligent as in protracted cases to supplement, if not altogether to supersede, the supervision of them by our students. In the selection of our compressing force we adopt in its widest sense the maxim 'Nullius addictus jurare in verba magistri.' Should one compressor prove irksome, we try another; if all should fail, we have recourse to digital compression or to compression by means of weights; but in every instance, convinced of the soundness of this plan of treatment, we leave no stone unturned to secure its success."

Compression by the Elastic Bandage of Esmarch.—The treatment of an aneurism by this method differs from all other forms of treatment by compression in that in it the blood is totally arrested in all the vessels of the extremity to which it is applied and not in the main artery alone, as in other forms of compression. Under such circumstances, the method has its own dangers, in addition to those it shares with others; and the chief I believe to be gangrene, due, apparently, to the clotting of the blood in the collateral vessels of the limb upon which its vitality depends. The following case illustrates the point.

The case was that of a man æt. 45, who was admitted into Guy's, under my care, in March, 1877, with a popliteal aneurism, which was increasing so rapidly that active treatment was called for. The man could bear neither digital nor instrumental pressure upon the afferent artery. I consequently applied the elastic bandage to the limb below the aneurism, using moderate pressure, allowed the aneurism to fill with blood, and then so compressed the thigh above the sac as to entirely check all pulsation in it, these three being apparently the essential points to observe. A subcutaneous injection of morphia was also given. The pressure was maintained for three hours consecutively and a second dose of morphia injected; but when the bandage was removed, the aneurism was decidedly harder, although pulsation still existed in it. Four days later all clot seemed to have disappeared, and, as the aneurism was as big as ever, the elastic bandage was again applied, only on this occasion, to soothe the man, an anæsthetic was used. This treatment was continued on this occasion for three hours, and at the end little had been gained from it. A fortnight was then allowed to elapse to allow the parts thoroughly to recover themselves, when a carbolized catgut ligature was applied to the artery, and within one week the wound had completely healed by immediate union, not a drop of pus having been exuded; indeed, the patient had no idea that any operation had been performed upon his thigh.

The foot, however, soon became the seat of anæmic gangrene, and a fortnight after the application of the ligature amputation in the middle of the leg was required and a

good recovery followed. At the amputation every arterial trunk was found obstructed. No vessel required torsion or ligature.

In this case I am disposed to attribute the gangrene to the employment of the elastic bandage, and fear that from its two applications the collateral vessels that would have carried on the circulation through the foot after the ligature of the femoral had become blocked, and, as a consequence, gangrene followed.

This plan of treatment was first suggested and carried out by Staff Surgeon W. Reid, R. N. (*Lancet*, 1875), and it has since been practised in more than 70 cases. I have employed it in 3. Mr. Pearce Gould, an able assistant surgeon of the Middlesex Hospital, has in an interesting paper[1] tabulated 72 examples, 35 of which or half the cases were cured. In 2 the treatment was doubtful; in 20 a cure followed the ligature of the artery; 3 were cured by compression and 1 spontaneously, and 1 (of bracheal artery) by the introduction of catgut into the sac. In 3 the artery was ligatured without success; in 3 death took place whilst under treatment, and in 1 the limb was amputated with a fatal result. Of the whole number of 72 cases—omitting the 3 of which no subsequent history was known after the failure of the method and the 2 doubtful—6 died, 35 were cured, and 25 were successfully treated by other means after the failure of Esmarch's bandage, in my own case after amputation—a result which is certainly encouraging. The method is most applicable to small sacculated aneurisms in fairly healthy subjects, and ought not to be practised when the aneurism seems thin and likely to rupture, and when by pressure it materially interferes with the venous circulation of the limb.

When employed, the bandage should be so applied as to secure complete blood stasis in the aneurismal sac and its adjacent artery, and this stasis should not in the majority of cases be maintained for more than one hour, or for more than two in any. The bandage should primarily be applied below the aneurism with sufficient firmness to arrest the circulation through the limb. It should be passed lightly over the aneurism, so as to support but not compress it; and when carried fairly above the tumor, which should be allowed to become well filled with blood, it should so constrict the limb above as to prevent anything like a circulation being carried out. In irritable subjects a subcutaneous injection of morphia should be given before the treatment is commenced, and in others an anæsthetic may be used. When the sac appears to have been filled with clot and pulsation in it has ceased, it is wise to have digital or instrumental pressure kept up upon the afferent artery for ten or twelve hours, and even when a doubtful cure has taken place a like treatment may bring about a good result. Indeed, in all cases of rapid cure of aneurism by this or other modes of compression this treatment should be pursued, because the clot that has filled the sac must of necessity be soft, and a very little may cause its displacement, and thus interfere with that natural contraction of the fibrin of the blood that is to fill the sac permanently, prevent its dilatation, and cure the disease. At Guy's Hospital, out of 17 cases of popliteal aneurism consecutively treated by pressure, 11 were cured; and Mr. Holmes informed us in his college lectures that out of 124 cases so treated in different hospitals, 66 were treated with and 58 without success. Of the latter, in 44, the femoral artery was afterward tied, and in 8 amputation was practised, 5 dying. Death occurred in 1 case and in 4 there was no evidence of subsequent treatment (*Lancet*, December 19, 1874). In the majority of these cases instrumental pressure was employed, and in some the treatment was imperfectly carried out.

2. Treatment by Direct Pressure.—The treatment of aneurism by *direct compression* next claims attention, and in modern times it is known as that by *flexion;* for there can be little doubt that the *modus operandi* of flexion in the cure of aneurism is mainly due to three conditions: *first*, to *direct* compression of the aneurismal tumor itself; *secondly*, to indirect compression through the medium of the tumor, intercepting either wholly or partially the supply of blood to the sac: and, *thirdly*, to displacement of the clot, as suggested by Holmes, and the consequent obliteration of the mouth of the aneurismal tumor. This mouth may likewise be so situated as to be closed by the bending of the artery, an aneurism in the posterior wall of the popliteal artery being in a far more favorable position for cure than one on the anterior. At the same time we know that forced flexion of a limb is capable of arresting the flow of blood through the healthy artery. In England, Mr. E. Hart demonstrated the success of this method of treatment in the year 1858,[2] although in 1857, Dr. Maunoir of Geneva recorded the first successful case in *L'Echo Médicale* (Neufchatel), and since that time many surgeons have successfully applied the practice. To carry it out, the limb must be carefully bandaged from

[1] *Trans. of Internat. Congress*, 1881, vol. ii. p. 209.
[2] *Med.-Chir. Trans.*, vol. xlii.; *Proceedings*, vol. iv.

below upward to the aneurism, and in the case of the popliteal artery the knee should be bent, sufficient force being employed to diminish or arrest the pulsation of the tumor, but no more, some turns of the roller maintaining the limb in this position. The thigh should then be flexed upon the pelvis and the patient turned on his side with the limb resting on a pillow. By this plan the arrest of the circulation through the aneurism may generally be effected and a cure expected. When the flexion is forced, the patient is too often unable to endure the suffering caused by the position. To large and rapidly growing aneurisms this method is inapplicable, and probably dangerous, as it may induce rupture; and when any inflammation or other complication exists, it ought not to be employed, nor ought it be persisted in when it is not obviously doing good. The plan, however, in small aneurisms is so simple, and when bearable is so successful, that it should always be attempted where it can be applied; and when unsuccessful, it is almost harmless.

Pressure may likewise be used with flexion where the latter is insufficient, many cases having been reported in which success followed the conjoint means. In one under my care in 1871 I cured aneurism below the popliteal space in eighteen hours by alternating the flexion of the leg with digital pressure in the groin.

M. Liégois in an interesting paper (*L'Union Méd.*, August, 1869) gives 11 cases in which flexion alone proved successful in popliteal aneurism, and also 11 in which it was successful in combination with other measures. In 4 it succeeded after other means had failed. On the other hand, it failed in 23 cases, or nearly half the whole number, and of these 7 are stated to have suffered rupture and 1 had inflammation of the sac. Holmes's statistics show nearly the same results.

3. Distal Pressure.—The compression of an artery on the distal side of an aneurism for purposes of cure claims a notice as a resource open to the surgeon when all others are inapplicable, since there is enough evidence to show that by such means an aneurism may be cured. In my own practice, in 1872, I treated a case of abdominal aneurism on this principle, and kept up pressure for sixteen hours; and, although the patient died from peritonitis, brought on by the pressure, the condition of the sac filled with clot was enough to prove the possibility of a cure being brought about. In the *Transactions* of the Royal Med. and Chir. Society, vol. lv., the case is published in detail, with some remarks on distal treatment which need not be repeated in these pages, although it may be stated, from my own cases, from Edwards's case of the innominate (*Lancet*, January 9, 1858), from Porter's (*Dublin Quart. Journal*, November, 1867), and others, that the distal treatment of aneurism by compression or ligature, whereby the efferent artery of an aneurism can be obstructed, claims the surgeon's close attention when other means are inapplicable.

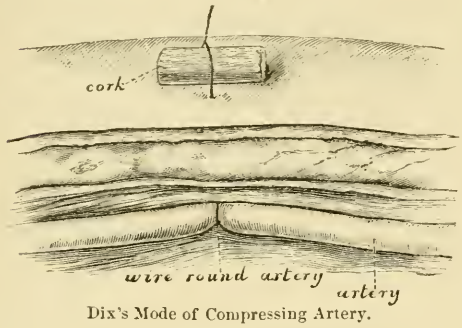
Temporary Occlusion of Artery.—The wire compress of Mr. Dix of Hull, already alluded to (see p. 346), requires naming as a means of dealing with aneurism. It is a method that has been advocated by Porter of Dublin (*Dub. Quart. Journ.*, November, 1867), Hilliard, and others (*vide* Mr. Dix's paper in the *British Medical Journ.*, October 30, 1875, p. 551). It is in reality treatment by compression, and not by strangulation. It does not cut the artery nor obliterate it at the seat of operation; therefore in principle and *methodus medendi* it ranks not with the ligature, but with the tourniquet and other modes of pressure. But, forasmuch as the application of the wire requires exposure of the artery by a cutting operation, this process cannot enter into surgical competition with the simpler methods of compression and flexion; yet where these have failed or are inapplicable, and operative procedure is inevitable, "then," says the author, "I back my operation, for certainty, rapidity, and safety, against any form of ligature—silk, hemp, or catgut—or against any kind of forceps, 'artery constrictor,' or compressor applied in or through a wound."

The operation is as follows, and it seems to be specially necessary to follow out the exact details with care and attention:

The artery is exposed by incision and the aneurism needle passed in the usual way. A piece of surgical wire about 9 inches long is threaded through the eye of the aneurism needle and carried beneath the artery by the withdrawal of the needle, which is then separated from the wire. A straight surgical needle is then attached to either end of the wire and the two needles (first one and then the other) are passed through the tissues to the surface, so that they emerge on the skin, one about a quarter of an inch and the other three-quarters of an inch from the edge of the wound, on whichever side of it may seem most convenient, *but both on the same side* (Fig. 152). By drawing them through together the wire forms a loop over the artery and the intervening tissues, and the needles are then detached from the wire. The half of a vial cork, flat side downward, is now

placed on the skin between the ends of the protruding wire and firmly pressed down by the fingers of an assistant *in the exact line of the artery*, the wire being at the same time drawn tightly upward and sharply twisted over the cork till the current through the artery is effectually stopped and the pulsation of the aneurism ceases. It is of great importance that the position of the cork should be longitudinally over the course of the artery, so that the blood current is checked as much by the downward pressure of the cork as by the upward tension of the wire, the intervening tissues forming a firm compressed pad. The superfluous ends of wire are then cut off and the wound closed and dressed according to the predilections of the surgeon.

FIG. 152.



Dix's Mode of Compressing Artery.

When the depression of anæsthesia goes off and the circulation revives, it will be found that a *feeble* pulsation returns in the aneurism. This, according to the author (who strongly advocates the *gradual* rather than the *rapid* method of producing coagulation in the sac), should be allowed to go on for two, or even three, days, when the wire is to be tightened in the following manner:

The cork being firmly pressed down over the artery, the wire is drawn upward by gentle traction on its twisted ends, and two or three small wooden wedges are pushed in *by an assistant* between the cork and the wire, so that sufficient tension is caused to *entirely* stop all pulsation in the aneurism. If the wire has been sufficiently drawn tightly, at first very small wedges are required, such as two or three bits of a lucifer match, for instance. The wire is on no account to be twisted afresh, lest it break. Meanwhile, by the action of the two or three days' feeble current the sac has been prepared, as it were, for the coagulation of *sudden soft* clot which is now formed, whilst the collateral circulation has also by the same means been encouraged, the result being that in from twenty-four to forty-eight hours consolidation is perfect; thus about the fifth or sixth day the cure is complete and the compress may be removed, which is thus done: Untwist the wire and remove the cork; separate widely the two ends of the wire, to lessen the curve as much as possible; clip off one end close to the skin; make gentle pressure with one finger where the cork has been, and by steady traction on the other end of the wire it is readily withdrawn. If it should seem to adhere, leave it till next day, when it must have become loosened in the tissues and will be easily removable.

The advantages of this method are thus summarized by Mr. Dix:

I. The wire does not cause ulceration or any damage to the coats of the artery, either external or internal; therefore, the blood channel being unopened, *bleeding*—one of the chief dangers of the old operation—*is impossible*.

II. By causing at first a *retarded* circulation and a diminished current it most accurately imitates the *natural* cure of aneurism, and by allowing time for the establishment of the collateral circulation the risk of gangrene—the *second great danger* of the ligature—is very much diminished.

If, nevertheless, there be coldness of the limb and a threatening of gangrene, the wire can be at once untwisted and relaxed, or even removed.

III. Ultimately the current through the artery and the sac is entirely obstructed, so as to produce the needful clot. Of course this complete obstruction can be effected at first if desired, and therefore this operation does what an operation by ligature or forceps cannot do—viz., it gives the surgeon a choice between the rapid and the gradual method of treatment.

It will be seen that in the opinion of the author the *gradual* method is much to be preferred, and he considers it one of the chief merits of his operation that this effect can be produced.

IV. The wire does not act as a foreign body in the wound, setting up suppuration and impeding the healing process, as a ligature does.

V. It is not a fixture upon the artery remaining for an indefinite period, but, its work being done, it can be at once got rid of.

VI. The clot produced by this concurrence of the gradual and rapid method is less likely to break down and suppurate than the soft sudden clot, which is the effect of the ligature.

VII. And lastly. As there is no possibility of bleeding from the artery, the surgeon has a wider choice of locality for operation. For instance, the common femoral or the external carotid, which on account of hemorrhagic risks is usually avoided by the operator, may be safely treated on this plan, which is, indeed, applicable to all arteries alike.

N. B. Inasmuch as it does not obliterate the artery at the site of the application of the wire, this procedure, *in its present form*, is not suitable for the distal operation; but it is probable that complete occlusion and obliteration may be effected by the simple modification of applying *two* wires upon the vessel about half an inch apart, between which a clot would form and become organized.

This method is quite trustworthy in traumatic aneurism and in a wounded artery, where a wire should be applied on either side of the orifice in the artery and the vessel divided between them. It has also proved successful in amputation, etc.

4. The Treatment by Ligature.—When the treatment of an aneurism by compression in one of its forms is inapplicable either from the position of the aneurism or from the unsatisfactory condition of the patient, or when such treatment has proved unsuccessful, then the treatment by ligature should be entertained; and this should be carried out by the Hunterian method (Fig. 153)—that is, by the application of a ligature at some distance from the sac, rather than by the "méthode d'Anel," in which the ligature is applied close to the aneurism. The advantages of the Hunterian operation are the slight flow of blood through the aneurism when the main flow is arrested, the maintenance of the collateral circulation, and the probability of the artery being more healthy at some distance from than close to the seat of disease. The operation is also, as a rule, less difficult.

FIG. 153.

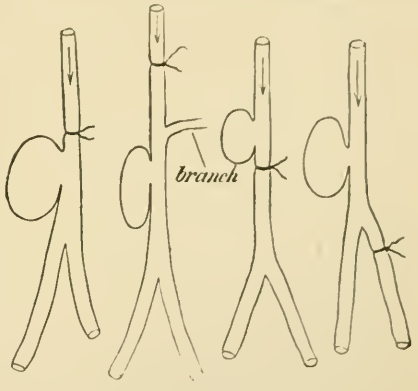


Diagram showing the Different Operations for Aneurism.

The ligature employed should be of either carbolized silk, ox aorta, kangaroo tendon, or prepared catgut. The ends of the ligature should be cut off short after the band has been tied, and an attempt should be made to get quick union of the wound. To leave the ends of the ligature long encourages suppuration and ulceration of the artery at the point of ligature; the vessel may ulcerate through or a portion of the artery may slough away with it—a process which takes from nine to twenty days, or more in large vessels. With the prepared catgut ligature now employed, some ulceration of the vessel at the seat of ligature may likewise follow, but a complete division of the artery by ulceration need not take place. On that account the catgut ligature is preferable.

Causes of Death after Ligature.—When the ligature fails and death ensues, it is from gangrene of the parts below the seat of disease or from secondary hemorrhage. The former is the more frequent cause of death, and, according to Dr. Norris, out of fifty fatal cases of ligature of the femoral artery, twenty-three died of gangrene and only eight of hemorrhage. To lessen the risk of hemorrhage some excellent surgeons have within the last few years returned to the old practice of ligating the artery in two places and dividing it between the ligatures. They have done this under the idea that by such a practice the tension of the vessel is lessened, and, as a consequence, the risks of bleeding are diminished. Signor Corradi of Florence follows this method, as a rule,[1] and Dr. J. Lidell advises it.

When a ligature is applied to the main artery of a limb, the circulation is for a time more or less cut off; consequently, coldness of the part, and even gangrene, may ensue. Congestion, however, generally takes place gradually in the extremity, from the blood being forced into the collateral vessels, and with this some increase of temperature may be felt, with hyperæsthesia. This point has been already noticed in my remarks on embolic arterial obstruction. Brown-Séquard explains the elevation of temperature that is often observed in a part after the application of a ligature to its main artery by the paralysis of the vaso-motor nerves that ramify on or in the coats of the vessel, this paralysis producing a corresponding paralysis of the ramifications of the vessels, and, as

[1] Ashhurst's *Internat. Encyclop. of Surg.*, vol. iii.

a consequence, the blood finds its way freely through the collateral branches into the part below the seat of the ligature; this increased activity of the collateral circulation produces the congestion of the part as well as the concomitant elevation of temperature (*Archives de Physiologie*, 1851). The surgeon should, however, after the application of a ligature do what he can to maintain the temperature of the limb, which is best effected by covering it thickly with cotton-wool, at the same time keeping the part raised, to encourage the venous circulation. Simple nutritious food should be allowed, but stimulants only with great caution, and in quantity merely enough to help digestion and maintain the force of the heart's action, the habits of the patient forming the best guide as to quantity. Should pain be present, opium, morphia, or chloral must be prescribed, either by the mouth or subcutaneously.

When the ligature has separated, the wound healed, and the aneurism consolidated, no forcible or prolonged exercise of the limb must be allowed for some weeks, although gentle exercise is beneficial. The limb should also be kept warm, for it has happened that the circulation through it has failed to become full or even sufficient after the operation, and some permanent weakness and loss of sensation has been left. A patient may, however, live a long life even after a double operation. In 1864 I saw a man æt. 51 upon whom Mr. B. Cooper had operated twenty-three years before (1841) for popliteal aneurism of the left leg, and of the right in 1843. He had been an orange-porter, and subsequently followed his work. When gangrene takes place, it is generally as a direct result of the cutting off of arterial supply from a limb and of the ensuing blood stasis. As a consequence, it occurs within a few days of the operation. It may, however, be produced by the presence of an inflamed or rapidly increasing aneurism, and has then little or nothing to do with the operation. It should be dealt with energetically. If it spread rapidly and threaten life, amputation of the limb about the line of ligature should be performed without delay. Should it, however, be limited in its nature and slowly progressive, the expectant treatment must be employed. The warmth of the limb at the same time should be carefully looked to, the sloughing or dying parts covered with well-oiled lint, the venous circulation assisted by the elevated position and by gentle friction, and the powers of the patient stimulated by food and wine, opiates being administered for the alleviation of pain.

When the sac of the aneurism inflames and suppurates after the application of a ligature, the case may be regarded as one of local gangrene the result of the operation; it is a dangerous complication and no definite rules can be laid down for its treatment. Hemorrhage is occasionally a result of this action, the blood coming from the lower end of the vessel; pyæmia or blood poisoning is another. In general, when an aneurismal sac suppurates, amputation is the best practice when it can be performed, and where it cannot the operation of Antyllus may be successful, as in a case of carotid aneurism reported by Mr. H. Morris, *Med. Chir. Trans.*, vol. lxiv. In August, 1871, I applied a ligature to the left carotid artery of a man æt. 29 for a large aneurism, and death ensued on the thirty-fourth day from suppuration of the sac and sloughing of nearly the whole aneurism. This process had been preceded by some hemorrhage on the thirteenth day after the operation. The same result may take place after the cure by compression, rapid or slow. It is an open question, however, whether aneurismal sacs that have been suddenly filled with coagula are not more liable to break up and suppurate than others in which the process has been more gradual.

In rare instances after the Hunterian operation the pulsation of an aneurism reappears, and a passing feeble pulsation in the sac a day or two after the application of the ligature is by no means a rare occurrence, nor need it excite any alarm, as it is doubtless due to the passage of a feeble current of blood through the sac by means of a collateral branch. This is more likely to occur when a cure by pressure has been previously attempted and failed, the collateral circulation having been enlarged by the pressure. Should, however, the *pulsation continue persistent*, even after the application of a ligature to the main trunk, it will be fair to infer that a "vas aberrans" exists, by which the blood is brought direct to the aneurism, and which must be ligatured before a cure can be expected. At times the existence of this vas aberrans may be made out at the time of operation, when the vessel must be looked for when the main trunk is tied; indeed, it may be possible that no necessity will be found to tie the main trunk, as the operation for aneurism is to tie the vessel that supplies the sac, and this may be connected only with the vas aberrans.

Operation of Antyllus.—Should it not be possible to apply a ligature to the efferent vessel, and the case is one in which other means are inapplicable or the aneurism is

clearly the result of a wounded artery, the formidable original operation for aneurism—that of Antyllus, practised more recently by Syme—may be required, which is the laying open of the sac of the aneurism, the removal of its contents, and the application of a ligature above and below its connection with the artery. To do this, however, much boldness and operative skill are necessary to prevent a fatal hemorrhage. With this object, in a case of axillary aneurism, Mr. Syme made an incision above the clavicle along the border of the sterno-mastoid muscle, to enable an assistant to compress the subclavian artery against the first rib,[1] acting upon the same principle as he adopted thirty years before, when he made an incision behind the angle of the jaw to enable an assistant to compress the internal maxillary artery before the removal of the upper jaw. In 1861 he laid open a gluteal aneurism, having previously thrust a bistoury into the tumor over the situation of the gluteal artery and introduced a finger, so as to prevent the blood from flowing except by occasional gushes. He eventually thrust his hand into the sac, rapidly turned out the clot, and had the bleeding orifice at once under subjection by the pressure of the hand. Both cases did well. Still, this practice is only applicable to desperate cases where all other modes of treatment have failed or are out of the question. In aneurisms of small arteries, however, it is very applicable. I have successfully employed it in many cases of aneurism of the radial and ulnar arteries for traumatic aneurism with good results, and in several cases I divided the vessel completely and twisted both ends, a rapid recovery following.

Distal Ligature.—When a ligature cannot be applied to the cardiac side of an aneurism and the treatment by compression has failed or is inapplicable, the distal operation of Brasdor or the application of a ligature to the vessel as it leaves the aneurism (Fig. 153) may be entertained, with the view of assisting coagulation of blood in the aneurism by "slowing" the blood current; for it may fairly be accepted, as proved by the cases of C. Heath, Annandale, Holmes, and Barwell, that the application of a ligature to the left carotid artery in aneurism of the aorta is of benefit. The credit of the suggestion, however, must be given to Dr. Cockle, who wrote on the subject (*Lancet*, 1869), although three or four cases had previously been recorded in which the operation had been performed with success for supposed carotid aneurism. Evidence likewise exists to show that the application of a ligature to the *right* carotid artery in cases of innominate or mixed innominate and aortic aneurism may do good. This practice is to be followed up, if needs be, by the application of a ligature to the subclavian vessel, Mr. Fearn's case and others having made the repetition of the operation justifiable. In August, 1871, I performed Wardrop's operation on a man æt. 33 for innominate aneurism. The subclavian was ligatured with a carbolized catgut ligature; the wound was closed and sealed with lint saturated with the compound tincture of benzoin. A good recovery ensued, and considerable consolidation of the aneurism. The man left the hospital thirty-six days after the operation so well satisfied with the success of the treatment that he did not return to have the carotid ligatured: indeed, he went on so well up to about six weeks before his death that he thought nothing of his trouble. He died from dyspnœa, the result of pressure, in August, 1874, three years after the operation. After death the aneurism was found to be full of solid clot, and there was a passage through it to the carotid, with a smooth lining. Unfortunately, the gentleman who took out the preparation threw away the bulk of the clot that filled the sac, which was as big as a fist. The success of the operation, however, was encouraging.

The Treatment by Manipulation.

This method was introduced into surgery in 1852 by Sir W. Fergusson,[2] and it is based on natural although exceptional processes—viz., the embolic occlusion of the distal end of an artery by a dislodged clot. It is practically to be carried out by the manipulation of the sac of an aneurism with the view of dislodging the blood clot it may contain, with the chance of such being carried by the circulation into the afferent artery. It may likewise be employed "to alter the relations of the laminated fibrine in the cavity of the aneurism, so as to bring about a further deposition of fibrine on the projecting surfaces of the displaced laminæ" (Oliver Pemberton's *Address on Surgery*, Brit. Med. Assoc.). Sir W. Fergusson practised it in two cases, and in both the success was sufficient to sanction the repetition of the means in appropriate cases and when all other treatment is out of the question. Holmes told us (*Lancet*, vol. i., 1873, p. 159) that it had been used in five cases of subclavian and two of femoral aneurism. In two cases a cure was obtained,

[1] *Med.-Chir. Trans.*, vol. xliii. [2] *Ibid.*, vol. xl.

and in a third it was probable. In cervical aneurism the practice is not applicable, on account of the dangers of embolism of the cerebral arteries.

Galvano-Puncture, or Electrolysis.

To induce or assist coagulation of the blood in the sac other means have been suggested, and of these *the treatment by galvano-puncture*, as advocated by Abeille in 1849 (*Arch. Gen. de Médecine*) and by Ciniselli in 1856, is one of the most promising in theory, though the practical results have not been equally satisfactory. It consists in the introduction of the two needles of a constant-current battery into the sac, with the view of coagulating the blood into a firm clot. The practice is one that can be entertained only in exceptional cases—*i. e.*, in those which cannot from their position be submitted to other forms of operation. It is, however, well adapted for the treatment of aneurisms at the root of the neck and the thoracic aorta, and possibly for some forms of abdominal aneurisms.

The constant-current battery should be used, and a moderate current, say of five cells, be first employed, its strength being increased gradually, but never to cause pain. The battery may be used for half an hour at a time, about twice a week, yet this will depend upon its effects. The needles should be of steel gilt, sharp, very fine, and about three inches long, and should be insulated to within half an inch of the point. They are to be introduced and removed with a rotatory motion, and may be attached to either pole of the battery. The dangers of the operation are, as stated by Holmes, principally from two causes, "the inflammatory action produced in the sac and the cellular tissue which surrounds it, and the gangrene or ulceration of the skin at the points of entrance of the needles."

Other Methods.

The treatment by injection is a mode that demands notice, although hitherto it has not been satisfactory. Alcohol, tannin, acetic acid, and the perchloride of iron have all been used as coagulating agents, but the last is the drug for which the most can be said. That it has a powerful influence in causing the coagulation of the blood is well known, but to produce this in the sac of an aneurism is a dangerous proceeding. The most dangerous result is embolism, and the next inflammation and suppuration of the sac. A solution of the perchloride diluted to one-twentieth the strength of the British Pharmacopœia preparation is strong enough, and not more than about twenty drops of the solution ought to be dropped into a large sac. The graduated glass syringe with screw piston should be employed, such as is generally used for subcutaneous injections. Care should be taken that the perforated trocar be well introduced into the cavity of the tumor, and that the afferent as well as efferent artery be well compressed. The escape of arterial blood is the only test of the trocar having entered the sac. The fluid should then be injected, and by manipulation mixed with the blood. When the sac seems solid, the canula should be withdrawn; but the pressure upon the cardiac side of the sac should be maintained subsequently for a full hour, to prevent the consolidating mixture of blood and iron being sent onward into the circulation.

With objects similar to the above, the late Mr. Moore inserted twenty-six yards of iron wire into an aortic aneurism through a canula, his object being merely to detain the fibrine of the fluid blood (*Med.-Chir. Trans.*, vol. xlvii.). Dr. J. Levis of Philadelphia in October, 1873, inserted twenty-four feet of horsehair into a thoracic aneurism in a man æt. 41 with some advantage, and on November 25, 1873, I adopted a like practice, introducing into the sac of a rapidly-increasing popliteal aneurism due to embolism twenty feet of horsehair through a fine canula, with the effect of causing almost complete consolidation of the tumor. The patient was a man æt. 33, admitted with ulcerative endocarditis, who survived the operation five days. Mr. Gould records a case in which a Dutch surgeon, Van der Meulen, cured a brachial aneurism in a woman æt. 22 by the introduction of catgut into the sac. The results thus obtained are quite sufficient, therefore, to justify a repetition of the operation under circumstances in which all other plans of treatment are unjustifiable or have failed.

In recent times Langenbeck, with the view of causing contraction of the walls of an aneurism, has been led to inject the parts surrounding the sac with a solution of ergotin. Dr. Dutoit of Berne relates in *Langenbeck's Archiv* (Band xii., No. 3) a case in which he successfully adopted the practice; the man was forty years old and the aneurism was supposed to be subclavian. Fifteen injections were made at intervals of two or three days *over* the tumor, which gradually diminished. To render the cure certain, however, digital compression was subsequently employed.

Traumatic Aneurism.

An artery receives a punctured or an incised wound; bleeding takes place; pressure is applied to control it, and the wound heals. In course of time a pulsating swelling is discovered at the seat of injury, and a traumatic aneurism is said to exist.

A man in wrestling or after making some sudden unprepared-for muscular exertion finds something give way in his leg or fancies he has sprained his knee. In a shorter or longer period a swelling appears in the popliteal space, which steadily increases and is pulsatile: he has become the subject of an aneurism. In the *former* case, doubtless, the injury was the direct cause of the aneurism; in the *latter* it produced it indirectly by acting upon a diseased vessel. And yet, if the former aneurism is sacculated either by the expansion of the reparative material with which the wound of the artery had been closed or by the hernial protrusion of one or more of the coats of the artery through a rupture or wound of the outer or by the condensation of the cellular tissue into which the blood has escaped, it differs in no single practical point from the latter or any other aneurism that has been already considered; and, what is more, it must be treated on the same principles, although, as the artery of a traumatic is healthier than that of a spontaneously formed aneurism, the traumatic may be more readily cured.

When, however, an aneurism caused by an injury is vaguely or not encysted, when either from the first it is "diffused" or it becomes so from the rupture of its sac, or *when any ordinary aneurism ruptures*, a different condition presents itself to the surgeon, and the case approaches that of a ruptured artery and is to be treated accordingly—that is, the artery is to be cut down upon, if possible, at the seat of rupture, and its two ends ligatured or twisted, or the aneurismal sac is to be opened and the operation of Antyllus performed. Amputation may be called for.

When with a sprain, fracture, or dislocation there is evidence by want of pulsation and other symptoms that the main artery of the part is obstructed, it is not to be assumed that the vessel is lacerated and should be cut down upon and tied, because a large proportion of such cases as these recover without any such proceeding being called for. Indeed, in one where the extravasation is severe and no pulsation exists, it is impossible to make out with any clearness the true condition of affairs. A limb either with or without a fracture may be greatly distended, and this from effused blood; but whether the blood has been poured out from the rupture of a large artery or vein or some smaller vessel there can be no means of knowing, since even the pulsation in the vessels below may be indistinguishable on account of the effusion. Under these circumstances no active proceeding can be carried out. The limb should be elevated, cold applied, and the case left to nature, and in a large number of instances a beneficial result will ensue. I can recall several such cases where I anticipated bad results, but witnessed good. If the effusion is so severe as to be followed by evidence of arrest of circulation in the limb, the surgeon will be justified in cutting down upon the vessel at the point where the history of the case indicates that it is wounded, and in tying both ends after having turned out all clot, etc. In other cases the main artery may be tied, but too often there will be nothing to be done but amputation, as gangrene may set in. This operation, however, must be postponed till the line of demarcation is fairly indicated. No general rule can, however, be laid down for the treatment of all these cases, as each one must be treated on its own merits.

But the student should remember—

1. That every encysted aneurism, however caused, is to be treated upon the previously described general principles.

2. That ruptured traumatic aneurisms are to be regarded as ruptured arteries.

3. That the rupture of an artery when bound down by a dense fascia, such as the popliteal, is generally followed by the complete arrest of both the arterial and venous circulation in the limb, and, as a result, by gangrene, which requires to be treated by amputation.

4. That in cases of partial rupture there may be less extravasation, and consequently less severe effects; under such circumstances pressure upon the main trunk above may suffice to bring about a cure, or, if this fail, the application of a ligature to the wounded vessel may be required.

5. That a ruptured artery in parts less fascia-bound than the leg (as, for instance, the arm) may be treated more as in the case of injuries to arteries, by the application of a ligature to the wounded vessel.

Collateral Circulation.—When an artery is obstructed, the circulation is carried on by what is called the collateral circulation, in which the vessels coming off above the

obstructed part communicate with those which arise below it. At first the vessels are very numerous, but as time goes on their number diminishes, and only those most con-

Fig. 154.
Anterior View.

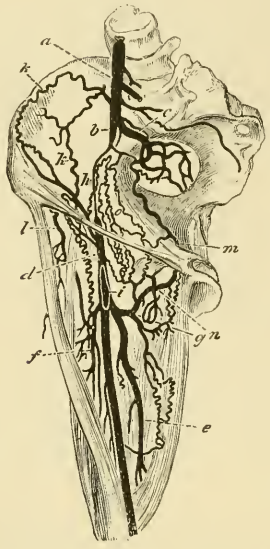


Fig. 155.
Posterior View.

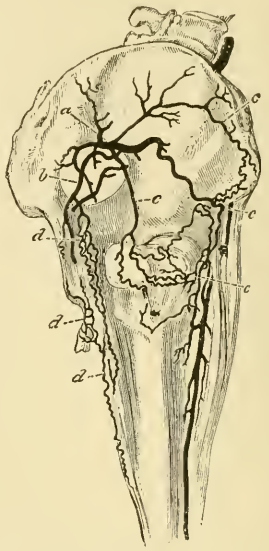


Fig. 154.—*a*, Common iliac artery. *b*, External iliac. *c*, Internal iliac. *d*, Femoral. *e*, Profunda. *f*, External circumflex. *g*, Internal circumflex. *h*, Iliac artery, which had been tied and had shrivelled into a cord. *i*, Remains of aneurismal sac. *k*, Anastomosing branches of the circumflex ilii. *l*, Anastomosing branches of the circumflex externa. *m*, Obturator artery, anastomosing with, *n*, circumflexa interna.
Fig. 155.—*a*, Gluteal artery. *b*, Ischiatic artery. *c*, Anastomosing branches of gluteal with the circumflex. *d*, Anastomosing branches of the ischiatic with the perforating branches of the profunda. (Prep. 1519[12], Guy's Museum.)

veniently situated for carrying on the circulation become rapidly or gradually and permanently enlarged.

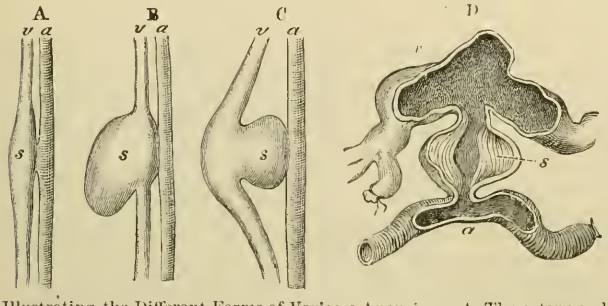
To illustrate this beautiful compensatory natural act I submit two drawings (Figs. 154, 155) taken from a preparation in Guy's Museum, made by Mr. Cock in the year 1826, from a patient æt. 58, in whom Sir A. Cooper had applied a ligature to the external iliac artery for femoral aneurism eighteen years and a half previously.

A full description and preparation of the case is to be found in the first volume (first series) of the *Guy's Reports*, by Mr. Cock. The drawings need no lengthy description, as they explain themselves.

Arterio-Venous Aneurism.

When an artery and a vein communicate with each other, the arterial blood passing *directly* into the vein without the intervention of a sac, *an aneurismal varix* is said to exist (A, Fig. 156); and when a sac exists into which the arterial blood flows in its passage to the vein, this condition is called *a varicose aneurism* (B, C, and D, Fig. 156). Both these varieties of arterio-venous aneurisms are now rare; but when venesection was a common operation, they were far more frequent, as they are usually produced by the perforation or division of an artery through a vein, the opening between the vessels remaining permanent. Both forms may originate spontaneously from disease. Goupil (Paris, 1855) recorded the fact that out of fifty-seven

Fig. 156.



Illustrating the Different Forms of Varicose Aneurism. A, The artery and vein directly communicating. B and C, The dilatation being more in the vein. D, Aneurism laid open.

cases of this affection, thirty-one were the result of bleeding. Cases are on record where the aorta and superior or inferior vena cava communicated. Wade (*Dublin Med. Press*, 1861) has recorded a case in which an opening existed between the aorta and pulmonary artery; in 1882 I saw a case with my colleague, Mr. Davies-Colley, in which this condition existed between the superficial femoral artery and femoral vein, the result of a gun-shot wound, and my friend Mr. Morris informs me that he has seen a like case in the femoral region, the result of a pistol-shot received by a sportsman in America. Indeed, all the large arteries and veins may be similarly affected.

In an **aneurismal varix** the vein assumes in some degree the properties of an artery and becomes enlarged from the arterial impulse. Besides being irregularly dilated and tortuous, the dilatation assumes a fusiform or sacculated appearance, while it also becomes thickened and pulsates, the mixed blood currents giving rise to a peculiar though characteristic "buzzing" murmur which when once heard is not likely to be mistaken.

In some instances the condition is congenital; it was so in the one illustrated (Fig. 157), in which the seat of communication of the vessels was about the axilla. The boy, æt. 14, was admitted under my care at Guy's in 1879 for bleeding from an open ulcer on his left index finger, the ulcer having followed an injury eighteen months previously. The injured finger was spongy from vascular tissue, and the palm of the hand had the appearance of a cutaneous nævus. The veins of the whole limb were immensely distended and thrilled very markedly: the buzzing murmur so generally present in these cases was very characteristic. The case was treated by elevation of the limb after it had been firmly fixed to a splint; under such care there was no recurrence of bleeding, and a rapid healing of the ulcer on the finger followed. It was not thought expedient to interfere with the disease.

Fig. 157.

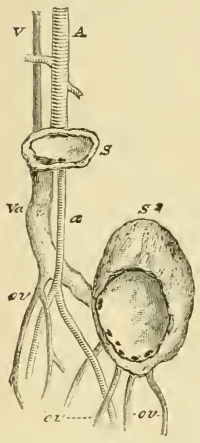
Aneurismal Varix.

In the **varicose aneurism** the sac may or may not freely communicate with the artery or vein. In some cases it will involve the whole calibre of both vessels, or the vein may be hypertrophied and enlarged, as in the aneurismal varix. In a unique case (Fig. 158), recorded by Mr. Cock (*Med.-Chir. Trans.*, 1851), of a traumatic varicose aneurism of the popliteal artery, the sac was small, but involved the whole calibre of the artery and vein, and the whole of the arterial blood passed through it. The secondary effects of the disease were also shown with singular clearness. It occurred in a man æt. 28 who eleven years previously had received a punctured wound in the popliteal artery for which two weeks subsequently, on account of secondary hemorrhage, the femoral was ligatured. He convalesced and returned to his work, but two years afterward became the subject of "varicose veins." He remained well until three or four months before his admission into Guy's, when he had fever, and on convalescing and trying to walk discovered his leg was stiff, painful, and swollen. He was admitted with what was supposed to be a large collection of pus beneath the superficial muscles of the calf. The femoral artery below Poupart's ligament and the anterior and posterior tibial arteries were pulsating freely. The cavity was opened; some ounces of dark grumous, pitchy, non-coagulable blood escaped. The next day a quantity of offensive pus flowed away mixed with coagula. For a fortnight everything went well, when arterial hemorrhage took place, and he lost nearly three pints of blood. After due consultation, amputation was performed, from which an excellent recovery ensued.

On dissecting the limb Mr. Poland found connected with the popliteal artery an aneurismal sac (Fig. 158, *s*) the size of a pigeon's egg, which was of cartilaginous hardness and lined with fibrine. The artery (*A*) freely entered the sac from above. The vein (*V*) was obstructed above with coagulated blood, and below was lost in the walls of the sac as a fibrous cord. From the lower part of the sac two vessels issued; the smaller one (*a*) was the continuation of the popliteal artery, *greatly diminished in size*, which divided as usual to the leg. The larger (*Va*) was the popliteal vein greatly hypertrophied, ponched, and puckered. It was quite pervious and passed down for about two inches, when it divided into two trunks: one, which accompanied the anterior tibial artery, was quite *obliterated*, the other led directly into a *second aneurismal sac* (s^2) the size of a

duck's egg, with the walls of which its coats became identified. It was this that had been opened. From the lower part of this *venous sac* emerged three or four large impervious branches that were clearly veins accompanying the posterior tibial and peroneal arteries. The contents of these veins could be washed out and the valves seen.

Fig. 158.



Mr. Cock's Case of Arterio-Venous Aneurism.

It should be added that the cutaneous veins above described as varicose were greatly hypertrophied, and it was evident that the whole of the blood from the leg was returned through them.

It would appear also that in this case, as a *direct* result of an injury, a *varicose aneurism* formed, into which the whole of the arterial blood flowed. Moreover—

That the arterial blood subsequently found a more direct course through the popliteal vein than through the artery, and as a result the vein became hypertrophied and the artery atrophied. Also—

That the force of the arterial blood current upon the thin coats of the vein caused the gradual dilatation of the vein and the subsequent formation of an aneurism in its course, and that by the giving way of this aneurism bleeding had taken place.

The wasting of the femoral vein *above* and the hypertrophy of the same vein *below* the upper sac, from its taking on the functions of an artery, are points of interest; and not the least important change was the great hypertrophy of the cutaneous veins through which the whole of the venous circulation of the leg must have been carried on.

I have given this case at some length because it illustrates better than any general description the whole effects, primary as well as secondary, of a varicose aneurism.

With reference to diagnosis, it may be stated that at the point of junction of the arterial and venous streams a peculiar burring bruit is often felt and heard, and this bruit frequently extends along the course of the dilated veins. Where a sac exists in which the two blood currents meet between the artery and the vein, there is likewise a soft bruit. The sac is rarely very large, and is made up of condensed cellular tissue and plastic matter.

Treatment.—In these cases surgical interference is not generally required. Should, however, the disease be extensive and either from pain, mechanical causes, or chances of rupture of the vessels require treatment, a cure may be attempted by the occlusion of the artery above and below the point of communication between the artery and the vein. The case should be treated as one of wounded artery. The vein need not be interfered with, as it will gradually wither so soon as its arterial communication has been cut off.

Pulsating exophthalmos, or vascular protrusion of the eyeball, associated with a marked swelling and enlargement of the vessels, a peculiar rushing bruit, and arterial pulsation, is an affection of much interest and of some obscurity, since it may be due to intraorbital aneurism, to rupture of the internal carotid artery into the cavernous sinus, or to some condition of vessels apparently independent of arterial disease. Mr. Bowman's dissections have fairly demonstrated that this affection may exist during life and after death show no pathology. Mr. W. Rivington has written an excellent article upon this subject (*Med.-Chir. Trans.*, lviii.), and has proved that in many cases this affection has been preceded by some fracture of the base of the skull, complicated, probably, with laceration of the venous sinus and obstruction or laceration of the internal carotid artery, and in idiopathic cases the like changes probably exist; in fact, some of these cases of pulsating exophthalmos had better be looked upon as examples of arterio-venous aneurism.

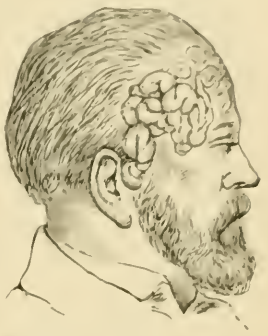
Treatment.—Some of these cases do well without treatment; but when they show evidence of steady progress, Rivington's facts clearly prove the propriety of applying a ligature to the common carotid artery, success having followed this practice in fifteen out of eighteen idiopathic and twenty-three out of twenty-six traumatic cases.

Cirsoid Aneurism, Erectile Tumors, and Aneurism by Anastomosis.

These have nothing in common with the spontaneous and traumatic aneurisms that have been already described beyond the fact that they are diseases of the arterial system. They are vascular tumors made up of arterial tissue and formed by a dilatation and elongation of arteries, the term *cirsoid aneurism* being employed when the trunks of the larger vessels are involved (*vide* Fig. 159), and *aneurism by anastomosis*, or cirsoid arterial tumors,

when the smaller vessels or capillaries are affected. In the cirsoid aneurism one vessel or many vessels may be diseased, the disease showing itself by the artery becoming tortuous, dilated into pouches, and convoluted. When one vessel alone is affected, Gosselin called it *arterial varix*. When the disease is on the scalp (its most common seat), three or four large tortuous arteries may be seen converging to the centre, where a congeries of dilated arteries will be found, probably of new growth. It may, however, affect the arteries of the extremity. I have seen it in the foot (Fig. 160), and Cruveilhier has reported a case in which the external iliac artery was so affected. Cirsoid aneurism is generally found in young people during the period of growth, and in the majority of cases can be traced to local injury. It can be readily made out by its pulsating nature and the peculiar tortuous and convoluted appearance of the diseased vessels, not only of the vessels forming the tumor, but of the arteries by which it is supplied.

Fig. 159.

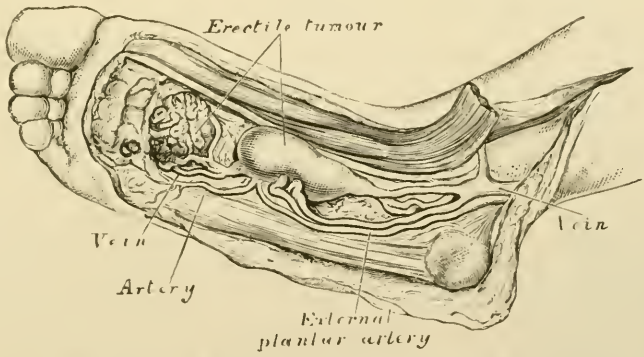


Cirsoid Aneurism of Temporal Artery. (Taken from a man æt. 43 who was under my care in 1881.)

Treatment.—All forms of treatment have been tried in these cases, such as direct pressure, injection, the application of ligatures to the vessels that converge toward the growth, and to the main artery that goes to the part; the tumor has, moreover, been laid open and treated by pressure, with the view of causing its obliteration by inflammatory exudation; Gräf, Bell, Arnott, and Lawrence have each recorded successful instances of this form of practice, but no good success in the majority of cases has been achieved.

The best success has, however, followed the removal of the growth, either by the application of the ligature or by excision. In 1876 I excised a cirsoid aneurism, situated below the jaw in connection with the facial artery, from a lady, æt. 25, with success. In

Fig. 160.



This drawing was taken from a patient of Mr. Poland's, a girl æt. 19. The disease followed an injury, and was treated by amputation, other measures having failed (*Guy's Hosp. Rep.*, 1869).

1867 I treated a boy æt. 14 for a large cirsoid aneurism of four years' growth, situated on the right temple. It was supplied with blood by tortuous vessels converging from all quarters, and pulsated freely. I applied acupressure pins to all these vessels, even to their division, without success; the growth for the time became flaccid, but quickly reappeared and increased. Under these circumstances I excised the tumor, making my incisions at some distance from its margin, and ligatured about twenty large vessels as I proceeded; a rapid recovery followed, and the boy was well three years later. In this case it was remarkable to see how rapidly the tortuous convoluted arteries that supplied the tumor withered and became of their normal size so soon as the central disease was removed. This process illustrates John Hunter's opinion that "vessels have a power of increase within themselves, both in diameter and in length, according to the necessity of the tissues, whether natural or diseased," and indicates that the attracting power had its centre in the growth, and not in the afferent arteries. In a third case, that of a girl æt. 12, I removed the aneurism by a subcutaneous ligature with like success, and more recently in a man who had such a vascular pulsatile growth in his left cheek, which appeared to have had all the afferent arteries tied without success before he came into my hands. I ligatured the whole mass subcutaneously, and a recovery followed. Four

years later, however, the disease returned, and in June, 1877, I excised it, the wound healing rapidly. Indeed, the only successful cases of treatment of cirsoid aneurism that I have dealt with or seen have been those in which the growth itself was treated by removal.

Cases of aneurism by anastomosis are very amenable to treatment by styptic injection, the galvano-cautery, or the ligature.

Nævus.

Telangeiectasis, erectile tumor, or angeioma, is essentially a disease of the capillaries, appearing in a general way to be made up of a mass of vascular tissue, the tubes freely intercommunicating with each other. It is true the walls of the vessels are indistinguishable in an advanced case of the disease, the nævus appearing as a collection of cells or spaces opening widely into one another, through which blood flows. When the arterial supply is very free, the growth appears florid, warm, and pulsatile, and is then called an *arterial nævus;* when the venous element predominates, the growth is less florid, has a congested bluish appearance, and does not pulsate, and is termed a *venous nævus.*

These growths for the most part appear in the skin or subcutaneous tissue, are frequent on the head and often multiple. Rare examples are on record where they affected deeper parts, even the viscera and the brain (*vide* Wilks and Moxon, *Path. Anat.*, and Morris, *Path. Trans.*, vol xxii.). In a clinical point of view they may be divided into the *cutaneous* or pure skin nævus, the *subcutaneous* or cellular tissue nævus, and the *mixed form*, where both tissues are involved; which distinction has an important practical bearing. Nævi are, as a rule, diffused—that is, they have no distinct capsule; but in many cases they are encysted and may be treated accordingly. Venous subcutaneous nævi appear to be more frequently encapsuled than the cutaneous and arterial.

Nævi, moreover, are generally congenital or make their appearance soon after birth. They occur, however, at a later period of life, and then seem to be due to some injury or wound. These nævi at times grow quickly, the cutaneous form rapidly spreading; the more florid and arterial the growth, the greater is its tendency to spread; the venous nævus is less progressive. They may grow also for a time and then stop; indeed, they all have a tendency to become stationary after a period, and even to degenerate. It is not uncommon to meet with nævi that have begun to undergo this process before the birth of the child, and I could adduce many cases in which the nævus was ulcerated, or even sloughing, at birth. In feeble or cachectic children it is not uncommon for these "marks" to ulcerate or slough, and after measles, fever, or other depressing illness the destruction of the growth is sometimes very rapid. These facts show that nævi, although blood tumors, are not long-lived growths and have a tendency toward early death. When they do not ulcerate or slough, they undergo degenerative changes, and the most characteristic is the cystic form (Fig. 161). When the skin undergoes this cystic change, the surface becomes warty and vesicular, the vesicles containing more or less blood-stained serum. When the cellular tissue is the part involved, cysts will still appear of a like nature, but occasionally the whole growth passes into a mass of cysts of different sizes bound together by fibrous tissue. This degenerative change is very typical. To account for the formation of these cysts is no easy matter; no satisfactory explanation, indeed, of their production has yet been given.

Fig. 161.

Drawing of Degenerating Nævus. (Guy's Mus., $\frac{1600}{4}$. Hilton's case.)

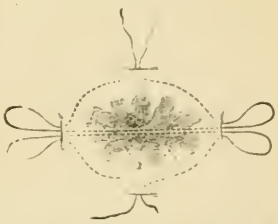
Some nævi are pigmentary, and are then termed "moles." They are far less vascular than the forms already alluded to and have no tendency to spread. They grow, it is true, with the growth of the subject, but as a rule in no greater proportion; in exceptional instances their increase is rapid. They do not appear to have a tendency to ulcerate, slough, or undergo the cystic degeneration like the vascular nævi, but have a special tendency to become the seat of disease, and particularly of the melanotic form of sarcoma or cancer—that is, subjects who become the victims of cancer and have moles are often attacked primarily in such structures, and, as the cancer originates in a pigmentary growth, it takes on its character and becomes melanotic. I have seen many such cases, and so many others have been now recorded as to place the question beyond doubt.

Treatment.—Unless a nævus is so situated as to be an eyesore or an inconvenience,

or unless it show a decided tendency to rapid increase, there is no necessity for operative interference. For a certainty, after a time, it will cease to grow, and also as certainly degenerate or waste; and under such circumstances it is not necessary to interfere. Should, however, the nævus be so situated as to be an inconvenience or a deformity, or should it grow so rapidly as to threaten to become either, something must be attempted; and this something is to be determined by the nature of the nævus and of the tissue in which it is placed. If *purely cutaneous* and not involving deeper tissues, it may be destroyed by some external application, such as caustic, nitric acid, or potassa fusa, chloride of zinc, ethylate of sodium, or tartarized antimony, the former two being applied directly to the part, the latter two in the form of Vienna paste or otherwise. The hot iron and the gas or galvanic cautery are also very valuable destructive agents, one touch of either of these latter, steadily applied to the surface or as multiple punctures, destroying the growth, and with but little pain.

In the *purely subcutaneous nævus* the treatment by caustics or cautery applied as a caustic is clearly inapplicable. When encysted, as very often it is, *excision* is the best remedy; but care should be taken to save the skin. When such treatment cannot be adopted, the nævus may be strangled by a ligature applied subcutaneously, as illustrated in the drawing, Fig. 162, or it may be injected with the perchloride of iron of the pharmacopœia strength, with a solution of tannin in water in the proportion of ʒj to ʒj, or of the chloride of zinc grs. xij to ʒj of water, about twenty drops being thrown into the centre of the growth, care being taken beforehand to tear up the texture of the tumor with a needle. The object of this treatment is to coagulate the blood in the tissue, and thus promote its consolidation and cure. In many cases injection causes inflammation, suppuration, or even sloughing of the growth; and though in this manner a cure may be obtained, it is often by deformity.

Fig. 162.



Mixed Nævus, with the Ligatures inserted round its Base subcutaneously before being tied.

The treatment by injection when the nævus is on the head or trunk is, however, attended with great danger, more particularly from embolism. I lost a patient where the nævus was on the cheek from this cause in a few minutes after the operation. For the above reason it is well to apply a ligature to the base of the growth and then inject, or to isolate the growth by means of the pressure of a metallic ring *before* injecting.

In the *mixed variety*, when the skin appears to have been involved secondarily by the extension of the disease from the cellular tissue, the nævus may be treated by excision, ignipuncture, subcutaneous ligature, or injection.

When the skin, with the cellular tissue, is extensively involved and the nævus defined, the whole may be removed by excision; but when otherwise, by ignipuncture or ligature. When the nævus is pendulous or when it can be isolated from the parts beneath, excision is most suitable; and when hemorrhage is dreaded, the base of the growth may be previously held in a flat clamp. In several instances I have excised the nævus by cutting on pins that have been inserted beneath its base, keeping the pins as points round which a ligature might be applied, and by which the edges of the wound might be brought together. When the thickness of the lip is involved in the disease and the disease is limited, a V-piece may be taken out with the growth advantageously; but when the whole lip is involved, the growth may be dissected out, leaving the skin. The drawing below is of a case in which this operation was successfully practised (Fig. 163).

Within the last few years I have successfully treated many of the mixed varieties of nævi with the actual or galvanic cautery by simply perforating them with the heated needle in many points (ignipuncture), introducing the needle at a black heat into the healthy margin of the growth down to its base. The cautery destroys the subcutaneous growth, and with it the skin.

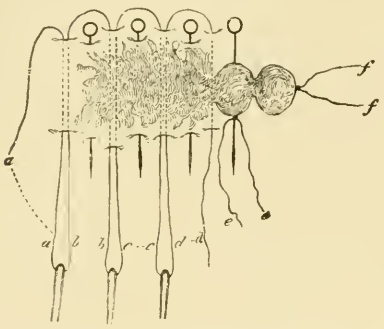
Fig. 163.

1. Nævus involving the whole of the upper lip. 2. After removal. 3. Flattening of the teeth from the pressure of the nævus. (From *Guy's Reports.*)

The treatment of a diffused nævus by means of setons is a practice that can also be strongly recommended. Several setons steeped in the solution of the per-

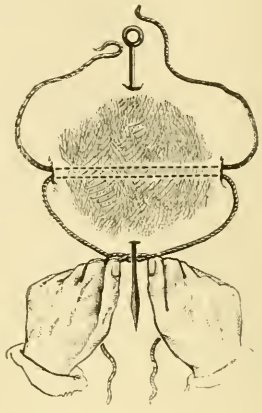
chloride of iron are often sufficient to coagulate the blood or to set up enough inflammatory action to cure the growth. When a nævus is extensive and is to be treated by the ligature, it may be dealt with piecemeal (Fig. 164). It occasionally happens that the

Fig. 164.



Illustrating the method of ligaturing a large mixed nævus in sections around pins. At one end the pin has been removed and the knot completed (*f*).

Fig. 165.

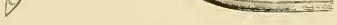


ligaturing of half a nævus cures the whole by the extension of the inflammatory action. In nævi involving the eyelids this suggestion is of value, and in my own practice several instances of cure have followed the application of a ligature to half the growth.

In a mixed nævus of moderate size, when the cure by ligature is to be carried out, a pin may be passed beneath the growth, and also a needle at right angles to the pin, armed with a double ligature (Fig. 165). The nævus is then strangled in halves by the ligatures tightly drawn beneath the pin, but before the ligatures are finally tightened it is well to puncture it to let out the serum and blood, to relieve tension, and to allow of the more perfect strangulation of the growth. When this act is completed, the pin may generally be removed.

Small nævi may be vaccinated, although the chances of a cure by such means are very small. The same also must be said for compression.

Fig. 166.



The best needle for the application of a subcutaneous ligature to a nævus is shown above.

Richet, "*Aneurism*," in *Dict. de Méd. et de Chir. Prat.*, vol. ii.—Léon de Fort, *Diction. Encyclopédique des Sciences Médicales*, 1866.—Broca, *Traité des Aneurysmes*, 1856.—Lisfranc, *Des différens Méthodes, etc. pour l'Oblitération des Artères*, 1834.—Scarpa, *On Aneurism*, Wishart's Translation.—Bellingham, *On Aneurism*, 1857.—Tufnell, *On Treatment of Aneurism by Compression*, 1851.—Holmes, *System of Surgery*, 3d ed., 1883.—Hodgson, *On Arteries and Veins*, 1815.—Dr. Norris, *American Journal*.—Dr. Stephen Smith, ditto.—Erichsen's Cooper's *Surgical Dict.*, 1861.—Wardrop, *Cyclop. of Surgery*.—Syme, *Observ. in Clinical Surgery*, 1861.—Fergusson, Sir W., *Med.-Chir. Trans.*, vol. xl.—Dr. Jones, *On Hemorrhage*.—Bryant, *Lancet*, April 4, 1874.—Gould, *Trans. International Congress*, 1881.—Holmes, *St. George's Hosp. Rep.*, vol. vii.—Ashhurst's *International Encyclop.*, vol. iii., 1883.

THE LIGATURE OF ARTERIES.—SPECIAL ANEURISMS, Etc.

John Bell wrote seventy years ago "that the right way of securing a great artery is perhaps one of the most important points in practical surgery:" and I may add that to do this with nicety and precision requires a sounder and more accurate knowledge of anatomy than any other operation.

"Before undertaking to tie an artery the surgeon ought to know its general course

and its relations, and especially the prominent part or parts which are to guide him to the position of the vessel; he ought to have familiarized himself by frequent dissection with the thickness of the parts covering it, and their appearance as far as that can be judged of in the dead body; and finally, he ought to know the usual position of its principal branches and the anastomosis by which the circulation may be expected to be restored. It is advisable also to be aware of the leading peculiarities in course, relations, bifurcation, etc., which the operator may perhaps meet with, and for which he ought to be prepared" (*Holmes's System*, vol. iii. p. 99). In fact, without anatomical knowledge, any attempt to tie the trunk of a large artery must be surrounded with difficulties and fraught with danger, whilst with it the operation becomes in the hand of an experienced surgeon an act of precision and apparent simplicity.

In a former chapter the mode of applying a ligature to a divided artery after operation was discussed and illustrated, and in the present attention will be directed to the application of a ligature to an *artery in continuity*, as in the operation for aneurism or the arrest of hemorrhage from a punctured wound. To accomplish this, the surgeon has to go through several stages of thought as well as of action. He has *first* of all to make out with precision the *exact course of the vessel to be ligatured*, which may be done by the artificial linear guides with which he ought to be familiar, the muscular guides to its position, and the recollection of the anatomical relations of the vessel.

He has, *secondly*, to decide on *the point at which the ligature should be applied*. When for a *wound* in the vessel, this point is already settled, it having been laid down as a rule that whenever possible a wounded artery is to be exposed at the seat of injury and two ligatures applied, one above and one below the seat of lesion.

Point of Selection.—When for *aneurism*, the question is more open, the "point for ligature" having to be determined by the surgeon. In deciding this important question it should be remembered that if the ligature be applied *too near* the aneurism, there is a risk of the ligatured vessel partaking of the disease for which the operation is required; and if *too far off*, the circulation through the aneurismal sac may be too free on account of the collateral circulation of the part.

But, above all, the surgeon should avoid selecting a spot *where an artery bifurcates or gives off large branches*, as under these circumstances the clot that is required to plug the vessel behind the ligature must be absent and one of Nature's most important hæmostatic agents become lost.

With the decision of these primary and important points the operation itself has to be considered, which resolves itself into *the exposure of the artery, its isolation, the application of the ligature around it, and the after-treatment*, the position of the patient for the operation being previously determined.

The position of the patient should be such as to render prominent the anatomical guides to the course of the artery, to make the skin tense, and to facilitate its division. *It should, moreover, be one of extension;* yet, after the artery has been exposed, it is well to remember that the muscles of the part must be *relaxed*, as the artery is thus better brought into view and the subsequent steps of the operation are rendered more easy.

The exposure of the artery is to be made by incision, its course having been clearly made out, and the point determined on beforehand for the application of the ligature. The incision should be in the course of the vessel, its centre corresponding to the point where the ligature is to be applied, an occasional obliquity being sometimes practised when the exact position of an intermuscular interspace in which the vessel lies is uncertain and when the artery lies deep. It should, moreover, be free. It need not be so long in a thin as in a fat subject, nor in the case of a superficial artery as in that of a deep vessel; but under all circumstances the skin wound should be enough to allow room for manipulation.

The first incision should include the skin and superficial fascia down to the deep fascia, and in making it the operator has only to avoid the division of any large vein, such as the external jugular in operations on the neck, or saphena in operations on the thigh. He should, consequently, mark out their position by arresting the circulation through them on their cardiac side and make his incision parallel with them when they lie in his course.

When the deep fascia is exposed, it should be laid open, and in this step the use of a director is sometimes valuable; the fascia, moreover, should always be divided to the full extent of the external incision. The student should remember that the trunks of all arteries except the cutaneous are covered in by fascia. With the division of the fascia the use of the knife can for a time be dispensed with, as the intermuscular septa and cellular

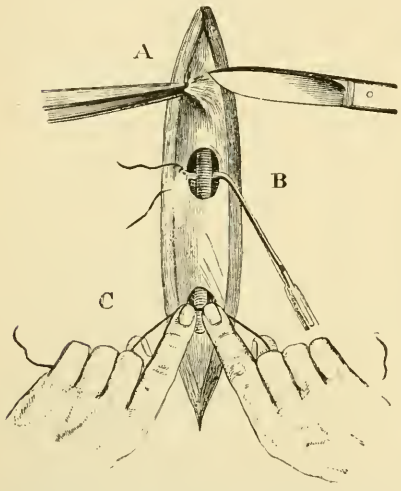
tissue are readily separated by the handle of the instrument or finger, so that the sheath of the vessel can be thus well exposed.

"If," writes Malgaigne, "immediately after the first incision, the surgeon attempts to find the artery, he tries an impossibility, since he cannot reach it till after the last incision." He will then proceed uncertainly and at random; hence the following rule of the guiding points: "The surgeon should not at the commencement occupy himself with looking for the artery, but should seek the first marked point of guidance, then the second, then the third, and so on to the end."

In looking for the sheath every anatomical guide is to be made use of, to prevent undue manipulation or separation of parts.

When the sheath is found and the pulsating artery is felt within, the end of the operation is not distant. Yet many errors may be committed. Every possible mistake should consequently be thought over beforehand in order to be avoided. The operator must ask himself as to the position of the nerves and veins about the part, so as to avoid them. He need not look for them as in a dissection, for this would necessitate superfluous manipulation, but their existence ought to be present in his mind. He should only remember their relative position to the vessel where the ligature is to be applied, and then guard against their being injured. The sheath having been found, it must be raised by the forceps and carefully opened (Fig. 167, A), such opening being only sufficient to admit a probe or aneurism needle; and the less the sheath is separated from its vessel the better. The needle (Fig. 168) with the ligature is then to be passed (Fig. 167, B), and it should be introduced between the artery and the vein, because when it is passed the other way the vein may be perforated or mistaken for fascia; yet in the hands of a careful surgeon this point need not weigh against convenience. With the exposure of the artery all anxiety ceases, for to put an ordinary silk, wire, or catgut ligature around it is a comparatively easy task with the majority of arteries; so when this is accomplished, the operation, as such, is all but completed. To do this, however, the surgeon must be careful not to elevate the artery from its bed by the ligature, but to tie the knot with his fingers well passed down to the vessel (*vide* Fig. 167, C). He should also satisfy himself, when the vessel is on the needle, that pulsation exists and that pressure arrests pulsation in the aneurism. When the ligature has been applied, the displaced parts must be readjusted, the wound cleansed, its edges brought together, and some light application employed, such as dry lint or water dressing. Where the artery of an extremity has been tied, the limb should be raised, to facilitate the venous circulation, and cotton-wool wrapped round the part, to maintain its heat; but beyond this no local treatment is required. It need hardly be stated that an anæsthetic should invariably be given in these operations, and that the subsequent treatment of the case should be based on general principles. When veins bleed or large venous trunks require to be divided, they may be tied or twisted, though gentle pressure often arrests bleeding from small vessels. The wound should be carefully cleaned during the operation by the firm pressure of a well-squeezed sponge; the edges should be held apart after the sheath has been exposed by hooked directors, but the surgeon on no account should allow his assistants to draw the parts so far asunder as to make them lose their relative positions. With these general remarks, the application of a ligature to special arteries will now claim attention.

Fig. 167.



This diagram represents three distinct operations: A, Opening of the Sheath. B, Drawing ligature round the artery. C, Tying artery.

Fig. 168.

Ligature of the Abdominal Aorta.

In 1817, Sir A. Cooper tied the abdominal aorta, having failed to find the communication between the common iliac artery and an aneurismal tumor, after the introduction

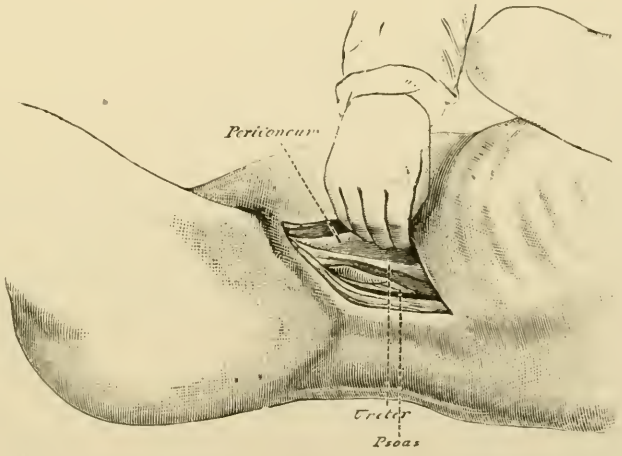
of his finger through a small opening in the ruptured sac. He made his incision through the linea alba to the left of the umbilicus, directly over the aorta. The patient lived forty hours. James of Exeter (1829), and Murray of the Cape of Good Hope, followed his example with no better success, the patients surviving three and a half and twenty-three hours respectively. In 1842 (*Lancet*, p. 334) Dr. C. B. Monteiro of Rio Janeiro recorded a case in which the patient died from hemorrhage on the tenth day. In 1856, Mr. South (*Lancet*, vol. ii.) operated on a patient who lived forty-three hours. In 1868 (*American Journal of Medical Science*) Dr. McGuire of Richmond, Virginia, recorded a sixth case, in which the patient lived twelve hours. In 1869, Dr. P. H. Watson of Edinburgh (*Brit. Med. Journ.*, 1869) is said to have performed the operation on a man who survived it sixty-five hours; and in the *Dublin Quart.* for 1869 Mr. Stokes, Jr., has recorded an eighth case, in which a temporary ligature was applied, but without success.

In all these the operation was performed for aneurism of the common iliac artery, but the results up to the present offer little encouragement for its repetition, more particularly when we have other means at our command holding out a better promise of success, such as pressure by the abdominal tourniquet while the patient is under the influence of chloroform. Cures of abdominal aneurism by this means have been recorded by Dr. Murray of Newcastle-on-Tyne (*Rapid Cure of Aneurism by Pressure*, 1871), Dr. Heath of Sunderland (*Brit. Med. Journ.*, 1867, p. 287), Mr. Holden (*St. Barthol. Hosp. Rep.*, 1866), Dr. Moxon and Mr. Durham (*Med.-Chir. Trans.*, 1872), and Dr. Greenhow (*ibid.*, 1873).

I believe, nevertheless, the operation of placing a ligature upon the abdominal aorta to be justifiable under exceptional circumstances, such as in cases of aneurism of the common iliac artery when all other means are inapplicable.

The best incision by which to reach the abdominal aorta is the *indirect*, a modification of that adopted by Sir P. Crampton[1] in the case of the common iliac artery (Fig. 169)—

Fig. 169.



Incision for the Application of a Ligature to the Aorta or Common Iliac Artery.

viz., one extending from the anterior superior spinous process of the ilium of the left side to the cartilage of the tenth rib, the peritoneum being reflected. The great difficulty in this operation is in the application of the ligature to the vessel.

Ligature of the Arteria Innominata.

The first operation was by V. Mott of New York in 1818, and since then this artery has been tied eighteen times, but only once with success (by Dr. Smyth of New Orleans in 1864, the patient living ten years), and in that case the carotid and vertebral arteries were likewise ligatured, the former at the same time as the innominata, the latter on the fifty-fourth day, for secondary hemorrhage. Dr. Smyth accomplished this on the suggestion made by Mott in 1818, when he wrote: "By thus intercepting the retrograde current through the primitive carotid there would be less chance of any reflux hemorrhage in the event of a phagedænic ulceration taking place in the wound." In all the other cases a fatal result rapidly ensued. Graafe's case lived sixty-seven and Thomson's

[1] *Med.-Chir. Trans.*, vol. xvi.

forty-two days (*Brit. Med. Journ.*, October 14, 1882). It can only be entertained, therefore, in cases of injury to the carotid or subclavian near their origin or in exceptional cases of disease. When decided on, the operation should be proceeded with as follows:

Operation.—The head being thrown back to the left and the shoulder depressed, the vessel may be secured by making an incision along the anterior border and sternal origin of the sterno-mastoid muscle, or by a transverse one over the upper border of the clavicle, making its centre correspond to the upper border of the sterno-clavicular joint, or by both combined. Under all circumstances the sternal, and sometimes a part of the clavicular, origin of the muscle will require division. The sheath of the cervical vessels will then come into view, with the internal jugular vein on the outer side of the carotid artery and the vagus nerve between them. On tracing these downward the innominate vessel will be reached. In a healthy subject the artery is always to be found behind the right sterno-clavicular joint, but in disease its relative position may be altered by mechanical displacement. Dr. Cooper of San Francisco has reached the artery on two occasions by removing the sterno-clavicular articulation. A stout animal ligature should be used.

In **aneurism of the innominate** there is no possibility of applying a ligature to its cardiac side, even if the disease involves only the upper part of the artery; yet, as a rule, this form of aneurism is almost sure to be associated with dilatation of the aorta. The distal operation, however, may be thought of, the carotid and subclavian arteries being ligatured simultaneously or consecutively. Of five instances in which the former practice was followed, one (Ensor's case, *Lancet*, July 31, 1875) lived sixty-five days and one recovered; while out of three of the latter an equal success may be recorded.

The credit of the successful case in the former class—for a success I take it to have been—belongs to Mr. C. Heath, who tied the subclavian artery in the third part of its course as well as the common carotid simultaneously in 1865. The operation was followed by marked relief and the diminution of the tumor; the woman, æt. 30, survived the operation four years, and died from rupture of the aneurism. After death the aneurism was found to be of the aorta, the innominate being only slightly involved. (*Vide* Prep. in Mus. of Royal Coll. of Surgeons, and *Path. Trans.*, vol. xxi.)

The successful issue to the case in the latter class belongs to Mr. Fearn of Derby, who tied the carotid in 1836, and the subclavian in the third part of its course two years later, for innominate aneurism. The patient died four months after the second operation, from pleurisy. I had an opportunity in 1866 (*Path. Soc. Trans.*, vol. xviii.) of carefully examining and reporting on this preparation, which is now in the College of Surgeons' Museum, and a better specimen of a cured small sacculated aneurism could not possibly be seen.

Aneurism of the innominate has likewise been treated by ligature of the subclavian or of the common carotid alone, Wardrop's operation; and in Wyeth's prize essay (New York, 1879) and *Holmes's Surgery* a most interesting list of references to such cases can be found. Out of eighteen, Evans's case, as recorded by Wardrop, was cured; his own lived two years. Morrison's case lived twenty months, two others lived six months, and the remainder lived only a few days or weeks.

In August, 1871, I ligatured the subclavian in a man æt. 33 for this affection, and a rapid convalescence followed, with great diminution and consolidation of the aneurism. The man lived three years after the operation (*vide* page 371). This result, therefore, is not so discouraging as to preclude the question of operation in favorable cases. It should only be entertained, however, under exceptional circumstances, and more as a palliative than as a curative remedy.

Ligature of the Common Carotid Artery.

This operation was first performed for aneurism by Sir A. Cooper in 1805, but unsuccessfully. The same surgeon, however, had a successful case in 1808, the man surviving thirteen years (*Guy's Hosp. Rep.*, vol. i.). The operation may be demanded for aneurism of the trunk itself or one of its branches, for erectile tumors of the orbit or of the scalp, etc., and for wounds or hemorrhage. It may also be called for as a distal operation in aortic aneurism. It is a dangerous, and sometimes a difficult, operation; but in a moderately thin subject it may be performed with facility. It should only be resorted to when all other means of treatment are inapplicable or have been found ineffectual; for aneurism it ought not to be performed unless the treatment by digital compression has been rejected. Holmes well sums up the matter in his *College Lectures* (1873) as follows: "That the experience of surgeons hitherto leads to the conclusion that aneurism of the trunk of the carotid artery may be very often treated successfully by compression, and

that the cure by compression frequently leaves the artery unobliterated, and therefore exposes the patient to a far less risk of cerebral mischief than the ligature; that the ligature of the carotid for such tumors is extremely dangerous and ought not to be undertaken until attempts well devised and perseveringly carried out have failed to effect the cure by compression; and that when the surgeon has been compelled by the position of the tumor to place his ligature close to the proximal side of the sac, it is worth very great consideration whether it would not be better to evacuate the tumor and tie the distal part of the artery also; finally, that cases do occur in which Brasdor's method holds out a rational hope of cure, but that this operation ought not to be practised except in cases of growing aneurism when digital pressure checks the pulsation of the tumor, yet has failed to effect a cure" (*Lancet*, June, 1873). The vessel may be ligatured in the upper part of its course at the apex of the carotid triangle, in a line with the cricoid cartilage, or lower down than this; the former position is the preferable and the operation there is more easy, and for disease of any of the branches of the vessel it should be selected. The latter should be resorted to only for disease of the upper part of the trunk itself. The course of the artery can always be made out, corresponding, as it does, with a line drawn from the sterno-clavicular joint to the angle of the jaw: the vessel divides on a level with the upper part of the thyroid cartilage and should be tied opposite the cricoid. The centre of the incision made to expose it should be opposite to the cricoid, and should extend about three inches along the anterior margin of the sterno-mastoid muscle. The position of the patient should therefore be such as to render this muscle prominent, which is ensured by the extension of the head backward, the face being turned to the opposite side.

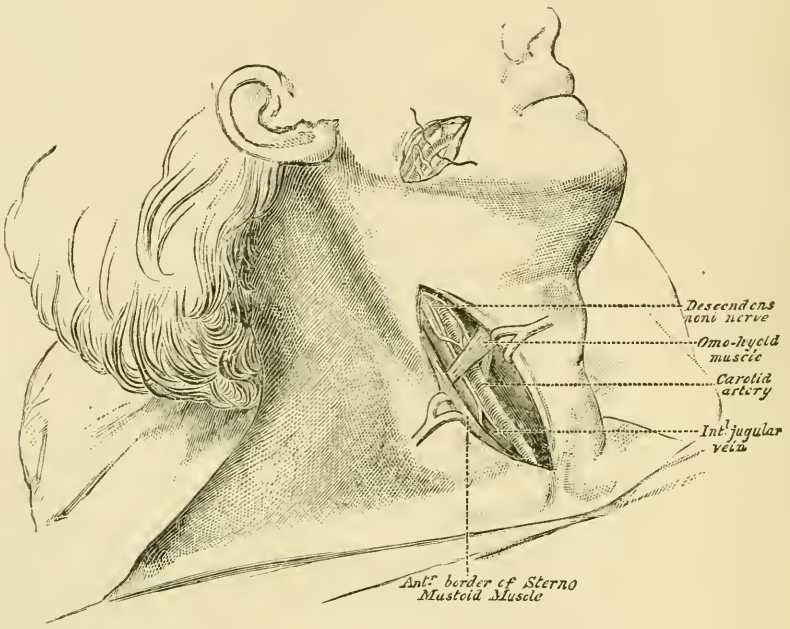
Operation.—Before making the first incision through the skin, platysma, and superficial fascia the surgeon should assure himself that no large vein, such as the anterior jugular, is likely to be divided; gentle pressure below, enough to interfere with the venous circulation of the part, readily supplies this information. The deep fascia covering in the sheath of the vessel may then be divided, care being taken to do this to the whole extent of the external wound. The sheath of the artery will then come into view, lying between the trachea and sterno-mastoid muscle; the pulsation of the vessel likewise can be detected. The head of the patient at this stage of the operation should be slightly raised, so as to relax the sterno-mastoid muscle and allow its being gently drawn outward by means of the retractor, as well as to permit of the separation of the cellular connective tissue of the part. The anterior belly of the omo-hyoid muscle will then probably be at once visible with its fibres passing downward and outward; and when this muscle is broad, it will cover in a great part of the vessel. The descendens noni nerve may likewise be seen lying upon, or sometimes within, the sheath; due care should be taken that it is not wounded or included in the ligature; and if it be in the way, it must be gently held aside by a retractor, as should be, also, any large vein that crosses the sheath. The inner border of the sheath is then to be taken up and firmly held with forceps, and a sufficient opening made in it by the knife, held with its flat surface toward the artery, to allow of the introduction of the aneurism needle. The needle is then, as generally recommended, passed *armed*, though this is not a point of importance, for *unarmed* it is passed with greater facility. By a little manipulation the needle may be passed round the artery from without inward, introducing it between the vein and vessel and keeping its point close to the artery. The sheath may be dropped from the forceps and the loop of the ligature seized, or the needle may be threaded and withdrawn. The surgeon must, however, satisfy himself beforehand that the right vessel has been exposed and that the vagus nerve is not included. The vessel can now be tied, great care being observed that it is not raised from its bed or manipulated more than is necessary; the knot should be tightened by the index fingers passed well into the wound. The wound should then be adjusted and the patient put to bed, the most perfect quiet being enjoined. The surgeon ought to remember all through this operation that the jugular vein is on the outer side of the artery and often overlaps it, while the vagus nerve is behind and the descendens noni in front (Fig. 170). None of these parts need be looked for, however, so long as care is observed that they are neither wounded nor included in the ligature.

The operation for ligaturing the *lower part of the carotid* is somewhat similar to the above: the operation is, however, more difficult from the vessel being deeper, particularly on the left side. The incision should in this instance extend lower down over the sterno-clavicular articulation. The muscles will also require more retraction, and probably some division.

Mr. Cock related to me a case which he authorizes me to quote, in which Mr. Aston

Key applied a ligature to the left carotid for aneurism and the man died on the table—indeed, died on the application of the ligature. After death it was found that the right carotid had been previously obliterated, and the operator had by ligaturing the left so interfered with the supply of blood to the brain as to cause death.

FIG. 170.



(This figure, with many others in this chapter, is based upon those given in Sedillot's work.)

With respect to the prognosis after this operation, much depends on the object for which it is performed. Dr. Pilz of Breslau (*Langenbeck's Archives*, 1868) makes out that 43 out of every 100 die; Dr. J. Wyeth of New York, in a careful analysis of 789 cases, gives 41 per cent. Pilz says that of 228 cases in which the operation was performed for hemorrhage, 128, or 56 per cent, were fatal; of 87 for aneurism, 31, or 35 per cent., died; of 142 for tumors, 49, or 34 per cent., died; of 71 for extirpations, 25 died, or nearly 34 per cent.; of 34 for affections of the nervous system, only 1 died, or 3 per cent.; and of 38 for aneurism on the distal or Brasdor's method, 25 died, or 65 per cent.

Secondary hemorrhage is a common cause of death, but brain complications are the more frequent, abscess in the brain and atrophic softening from want of arterial supply being the usual form—local gangrene, as it were, of the brain. Brain symptoms in some of their forms also occur frequently after the operation, when death does not take place simply from altered cerebral circulation. Suppuration of the aneurismal sac is not unfrequent, and in a case of my own it was the cause of death.

Ligature of the external or internal carotid artery has been rarely performed, the ligature of the common trunk being preferred; but the wisdom of this practice is not very clear. Mr. Cripps has shown, in a valuable paper upon the treatment of hemorrhage from punctured wounds of the throat and neck, that the application of a ligature to the *external* carotid above the superior thyroid artery or one inch above the bifurcation of the common carotid is the "point of selection" for the application of a ligature. The incision for the operation should be made in front of the sterno-mastoid muscle from behind the angle of the jaw downward to a point below the level of the thyroid cartilage. The deep fascia and parts over it having been divided, the facial and lingual veins will be seen. These may be turned aside or ligatured and divided if in the way. The artery will be found behind the stylo-hyoid and the posterior belly of the digastric muscle, crossed by the hypo-glossal nerve, with the internal jugular vein and internal carotid artery along its outer side.

The same incision is required for the application of a ligature to the internal carotid artery.

Dr. John A. Wyeth of New York in an able prize essay (1878) advocated this view. He shows that out of 91 cases of ligature of the external carotid only 4½ per cent. died, and asserts that the common carotid artery should never be tied for a wound of the external or one of its branches when there is room enough between the wound and the bifurcation of the common carotid to allow of the application of a ligature to the external.

In the *New York Med. Journal*, (January, 1874) a case is recorded by Dr. H. P. Sands of New York of successful ligature of the *internal* carotid artery above and below the bleeding point for secondary hemorrhage occurring ten days after the removal of a cancerous tumor. This operation has been performed four times.

Cervical aneurisms situated on one of the secondary carotids should be diligently treated by compression, and the Hunterian operation performed only when treatment by compression has failed.

The lingual artery has been ligatured for wounds of the tongue and of the artery itself, to check the growth of cancerous tumors, or to arrest hemorrhage from their substance. The operation is difficult. The trunk of the vessel is always to be found at a point *above the great cornu of the hyoid bone*, and this point must be rendered prominent by the head being well drawn over to the sound side and there held. The best incision is horizontal, on a level with the hyoid bone, its centre corresponding to the end of the greater cornu. The skin and fascia having been divided, the submaxillary gland will become exposed. On hooking this upward and dividing the border of the mylo-hyoid muscle the hypoglossal nerve will be seen resting on the hyoglossus muscle. Beneath this muscle, and at a lower level than the nerve, the artery will be found. It is in close contact with the tendon of the digastric muscle. The fibres of the hyoglossus will always require division to admit of the ligature being applied. Fig. 171 illustrates these points.

An excellent paper on this subject by M. Demarquay may be referred to (*Gaz. Méd. de Paris*, 1867).

The facial artery is always to be found in the greater part of its course close to the anterior border of the masseter muscle, where it is only covered in by skin, platysma, and fascia; and at this part a transverse or oblique incision at the lower insertion of the muscle will expose the artery, where it can be ligatured (*vide* Fig. 170). It is difficult to understand under what circumstances this operation can be called for, as the artery can be so readily controlled by pressure, an acupressure needle and twisted suture over it being the best form to employ. But where the artery comes off from the external carotid and lies in the submaxillary gland beneath the jaw, it is somewhat deep and an operation for its ligature by no means easy. I have, however, had only one opportunity of practising this operation, and it was on a lady æt. 25 who was suffering from a cirsoid aneurism of the vessel as it passed through the submaxillary gland. The operation was successful. I saw the case with Dr. Helsham of Brixton.

The temporal artery can always be found and pressed upon in front of the pinna of the ear, over the zygoma. It lies buried in the dense cellular tissue which exists in this spot beneath the skin and fascia, and can readily be exposed by a vertical or oblique incision an inch long, one-third of an inch in front of the tragus.

The occipital artery can be traced by a line drawn from the mastoid process to the occipital protuberance, and lies beneath the skin and cranial aponeurotic origins of the sterno-mastoid, splenius trachelo-mastoid, and digastric muscles, which must be divided to reach the vessel in the deep part of its course. The artery can be felt about the centre of the line mentioned.

Ligature of the Subclavian Artery.

This operation in the *first part* of the vessel's course has been performed twelve times, but never with success. It is an unscientific as well as an unsuccessful operation, and, for disease it is scarcely a justifiable proceeding, though for a wound it may perhaps be entertained. The incision for the operation would be similar to that for the innominate.

The point usually selected for the application of a ligature to the subclavian is in the *third part* of its course, where the artery emerges from behind the scalenus muscle. This operation may be demanded for aneurism of the axillary artery or for a wounded vessel.

Aneurism may affect the subclavian artery in any part of its course; it may involve the whole of the artery or be confined to its first or third portion. When situated on the artery to the inner side of the scaleni muscles, it may be mistaken for an innominate or aortic aneurism, or a common aneurism may involve all these vessels on the right side of

the body. When affecting the artery external to the scaleni, it is most frequently associated with disease of the axillary artery.

The DIAGNOSIS of subclavian aneurism is by no means easy, and is thus referred to by Nélaton:

"In subclavian aneurism the tumor extends, generally externally, to the clavicular origin of the sterno-mastoid muscle, reaching the posterior and inferior triangle of the neck; becomes more elongated transversely than vertically; the bruit is propagated more toward the axilla than the neck, and remains the same on compressing the carotid; the the radial pulse enfeebled; the limb painful and œdematous and incommoded in its movements. In carotid aneurism the tumor is seated between the sternal and clavicular origins of the sterno-mastoid muscle, becomes more elongated in a vertical direction than in a transverse one, and on auscultation gives to the ear a *bruit de souffle*, which is propagated more toward the side of the neck than the arm, with diminution of the arterial pulsation in the corresponding side of the face and cranium, and without weakening the radial pulse on the same side. In innominate aneurism the tumor is placed under the sternum or at the inner border of the sternal portion of the sterno-mastoid muscle, with weakening of the pulse in the subclavian and carotid arteries, and with absence of the other signs peculiar to the two other forms." When a cervical rib is present and the subclavian artery passes over it, the existence of aneurism may be simulated; but the knowledge of the fallacy should prevent such an error of diagnosis being made.

The PROGNOSIS must always be regarded as unfavorable, for these aneurisms are peculiarly liable to become diffused even in the early stage of their development as a visible tumor; yet there are several instances on record of their slow progress, and some fortunate examples of their ultimate cure by natural efforts.

The TREATMENT of these aneurisms is most unsatisfactory, the space at the disposal of the surgeon being so limited that he is at a loss to know where he can attack the disease by the few means that are at command. Ligature of the first portion of the subclavian, ligature of the innominate, the distal ligature of the subclavian and axillary arteries, and ligature of the carotid have all been performed, and, with one exception, been attended with fatal results. The exceptional case is that of Dr. Smyth of New Orleans, who tied the innominate and carotid, and subsequently the vertebral artery on the fifty-fourth day. It is only in small aneurisms occupying the third portion of the artery and the commencement of the axillary that the operation of tying the subclavian external to the scaleni has been successfully performed, and in some of these instances the outer fibres of the scalenus anticus muscle have been obliged to be divided.

The amputation at the shoulder-joint on the distal side of the aneurism has been suggested by surgeons for the cure of the disease. It has, too, been successfully performed by Professor Spence of Edinburgh.

Galvano-puncture has been successful in one case by Abeille, and *escharotics* in another by Bonnet. *Manipulation* has been employed by Fergusson in two cases and by Lidell in one case, with satisfactory results in the latter one only. A case of Porter's may also be accepted as successful. *Direct compression* of the aneurism has been tried by Warren with a favorable issue, although much danger was risked in the proceeding. Corner's case (*Med.-Chir. Trans.*, vol. lii.), though one not actually of the same kind, was a very good instance of the value of preventing an aneurism from enlarging and exerting such moderate compression as to incite fibrinous deposition in the interior of the sac. Poland's case of successful *pressure on the artery* on the cardiac side of the aneurism is quite exceptional. Gay also has recently met with success. The use of *acupressure* by Porter, though successful on the distal side of the aneurism, proved fatal when applied on the cardiac side to the innominate artery, and *injection into the sac* was performed in one case with a fatal result. Langenbeck has recently injected the parts over the aneurism with a *solution of ergotin*, the object being to cause contraction of the aneurismal sac. Such is a list of the means which have been resorted to, but the success has never been great. The question naturally arises, therefore, whether we should not discard such measures and treat these aneurisms on the ordinary principles of internal aneurisms, by rest, attention to diet, and medicinal remedies.

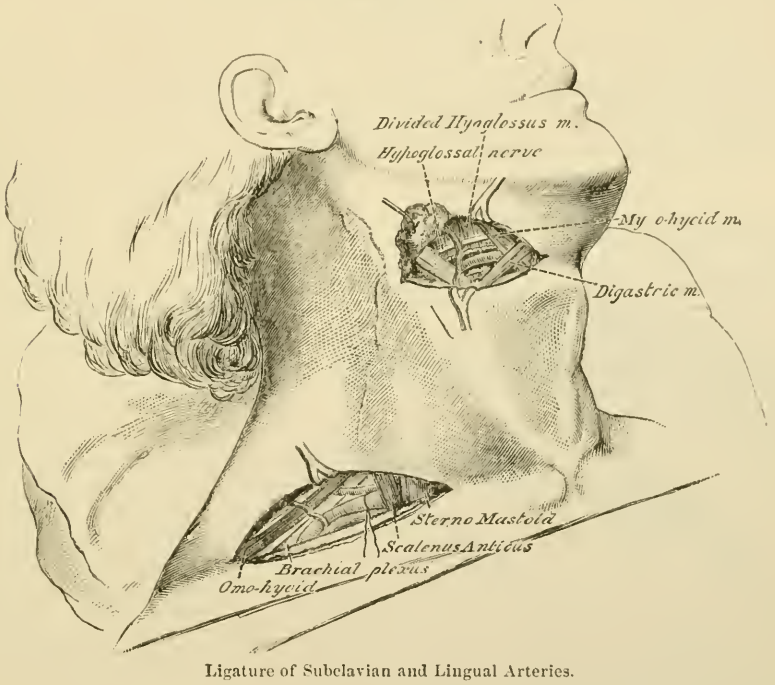
Mr. Poland, in an admirable essay in the *Guy's Reports* for 1870, gives a very favorable return of cases which he has been able to collect in reference to this question of treatment. It stands thus: Out of 13 that underwent *general and local treatment*, 7 recovered, 1 was relieved, and 5 died; out of 22 cases in which an expectant treatment only was pursued, 4 recovered and 18 died; thereby giving a total of 11 recoveries and 23 deaths, 1 being relieved. Of the 23 fatal cases, the duration of life was noticed in 17.

In 21 cases in which the subclavian artery was ligatured in the *third part of its course* for aneurism, 9 recovered (in 6 of these it was the left artery that was ligatured), and 12 died; 8 of the deaths were due to hemorrhage and 4 to brain complications or other symptoms. Poland's facts thus accord well with Koch's, who gives 36 recoveries out of 65 cases, something less than half dying—a success which is in a degree encouraging to surgeons to undertake the operation.

Operation.—It has been already stated that the application of a ligature to the subclavian in the first part of its course is scarcely a justifiable operation, but when undertaken the incision on the right side would be similar to that for the innominate; on the left side it is scarcely practicable, on account of the depth and relations of the artery.

In the *third part* of its course the operation should be performed as follows (the method being similar for both sides): The patient should be raised on a pillow with his head thrown back and face turned to the opposite side, an assistant drawing the arm down as much as possible, to depress the shoulder. An incision three or four inches long should then be made on the upper surface of the middle of the clavicle (Fig. 171)—

Fig. 171.



Ligature of Subclavian and Lingual Arteries.

not above the bone, as the external jugular vein might then be wounded. Some surgeons advise the skin to be drawn down from the neck upon the clavicle, so as to diminish this risk. In this incision the skin with the superficial fascia and platysma will be divided. The deep fascia is then seen with the external jugular vein coursing over it; this must be held aside with a retractor. When its division is a necessity, it should be done after the application of two ligatures, one above and another below the line of section. The cervical fascia can then be divided in the whole extent of the wound, and this must be done with care on a director. Should more room be wanted, a portion of the sterno-mastoid or trapezius muscle may be divided. The knife is now to be laid aside and the artery looked for in the space exposed, the parts being separated by a director or the handle of the scalpel. The vessel will be found just on the outer side of the scalenus anticus muscle (the edge of which can generally be felt) and behind the tubercle on the first rib, a point which can almost always be made out. Several arteries of large size will probably be found crossing this space, as well as many veins. The supra-scapular artery and vein will always be seen behind the clavicle. The brachial plexus lies above and behind and the subclavian vein in front and below the subclavian artery. When the vessel is seen or felt, the sheath is to be opened and the aneurism needle passed around it from above downward, care being taken not to injure the vein or include a nerve.

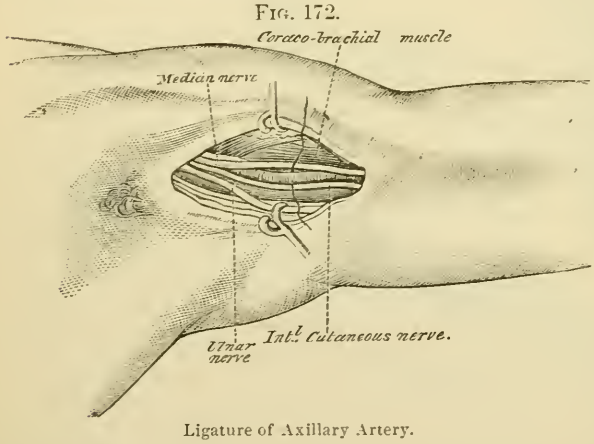
Ligature of the Axillary Artery.

This is a rare operation, although it may be demanded for some wound of the vessel or for aneurism of the brachial. It may be performed in one of two positions—either immediately below the clavicle or in the axilla.

The subclavicular operation is carried out by an incision made immediately below the bone from the coracoid process to the sternal end of the clavicle, dividing integument and fascia and carefully avoiding the cephalic vein that runs along the anterior border of the deltoid to join the axillary. The clavicular origin of the pectoral muscle will be divided, and the deep fascia or costo-coracoid membrane covering in the sheaths of the vessels will be then exposed and divided. In this step of the operation some of the branches of the thoracic acromial artery will come into view, and if wounded must be secured. The coracoid insertion of the pectoralis minor can also be seen. The fascia covering in the vessels will be exposed, and on laying it open the greatest care is necessary, as the axillary vein lies immediately beneath it, while above will be found the vessel resting on the first intercostal muscle. The brachial plexus is above and behind. The axillary vein should be drawn downward and the aneurism needle passed from below upward, care being taken not to include the external respiratory nerve of Bell that passes behind the artery. When the vessel has been exposed, the passage of the ligature will be facilitated by bringing the arm down to the side of the body. On the dead subject this operation is not difficult, but the number of veins and arteries that exist in the space must ever render the operation on the living far from easy.

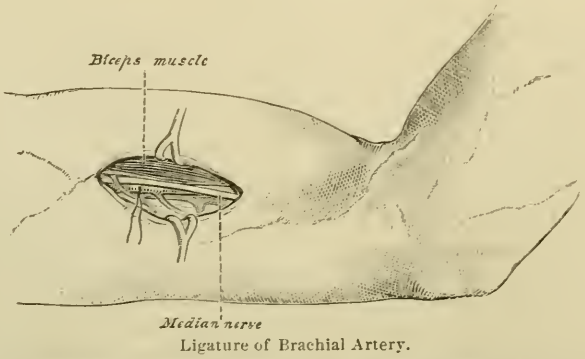
To tie the axillary artery in the axilla, the arm should be well raised upward and the course of the vessel marked out slightly posterior to the middle line of the axilla. An incision should then be made along the inner margin of the coraco-brachialis muscle through the skin and fascia for about two or three inches and the deep fascia exposed. This should be carefully divided to the whole extent of the wound, when the artery with its attendant nerves and veins will come into view. In this stage of the operation the forearm should be flexed on the arm, to relax the parts. The vessel, as a rule, has the median nerve on its outer side and nearer to the pectoralis major muscle, and the vein and ulnar nerve to its inner side. The internal cutaneous nerve is in front. (*Vide* Fig. 172.)

Fig. 172.



Ligature of Axillary Artery.

Fig. 173.

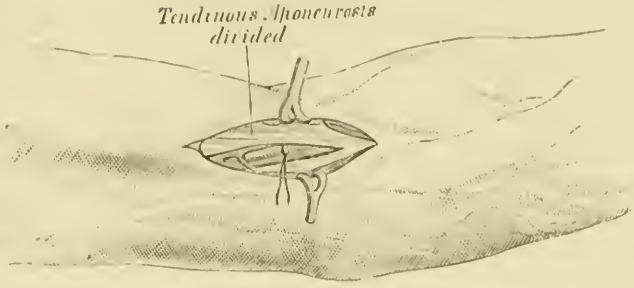


Ligature of Brachial Artery.

Mr. Guthrie condemned the subclavicular operation altogether, and advised the surgeon to expose the artery by an incision three inches long, carried upward along its

course, commencing at the lower border of the pectoral muscle; yet few have followed this advice, most surgeons preferring the operation named subclavicular, one of its modifications, or the ligature of the subclavian. For the superior operation Mr. Erichsen prefers an incision made from the centre of the clavicle downward in the course of the vessel

Fig. 174.



Ligature of Brachial Artery.

to the middle of the anterior fold of the axilla, such incision necessitating the division of the great pectoral muscle, and often of the small. He says "that this division need not leave any permanent weakness of the limb, as by proper position ready union may be effected between the parts."

In all these operations on the axillary artery the surgeon must ever be on the outlook for abnormal division and relations of the vessel.

Ligature of the brachial artery is a very successful operation, and may be demanded for direct injury to the vessel, hemorrhage from a wound of one of its divisions in the hand or fore-arm which cannot be treated locally, aneurism, etc. It can be performed readily in any part of its course. The middle of the arm is the best point to choose. The course of the vessel is indicated by a line drawn from the middle of the axilla to the inner side of the biceps tendon at the bend of the elbow, while the inner border of the biceps muscle is the guide to the incision.

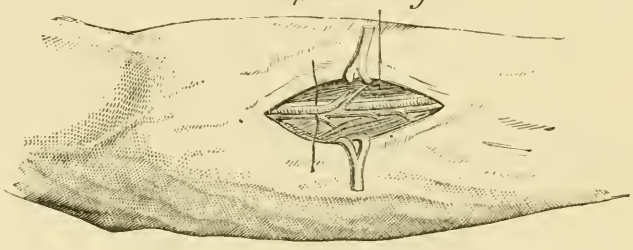
Operation.—The vessel may be exposed by a cut, two or three inches long, made in this position, with the arm extended and supinated. The skin, which is always thin, and the fascia should be carefully divided, and the deep fascia which is thus exposed ought then to be laid open, but with care, for the basilic vein lies immediately below it on the inner side of the brachial artery. The ulnar nerve will be found on the inner side of the vein and the median in front of the artery, but there is no regularity in these relations; consequently, much care is required in finding the vessel and discretion in trying it, for a high division of the vessel or the existence of some vas aberrans may mislead and confuse. When the right vessel has been found, the application of a ligature is readily concluded. In performing this operation care must be taken not to open the sheath of the biceps muscle, and it should be remembered to flex the fore-arm on the arm after the division of the deep fascia has taken place. In several cases in which the occlusion of this artery was required I have divided it and torsed both ends with excellent results.

Ligature of the brachial in its lower third is now rarely performed. In the days of bleeding it was by no means unfrequently required for traumatic aneurism, though it has never fallen to my lot to witness its performance for such a cause. The operation may be performed with the fore-arm extended by making an incision two and a half inches long on the inner side of the tendon of the biceps, care being taken to avoid the large veins that ramify in the superficial fascia. The tendinous aponeurosis of the biceps will then come into view, and on its division the artery will be exposed with its venæ comites, the tendon of the biceps being on its outer and the median nerve on its inner side. The fore-arm should then be flexed after the artery has been exposed, when a ligature can be passed without trouble.

Ligature of the Radial Artery.—A line drawn from the *outer* side of the biceps tendon at the bend of the elbow to half an inch internal to the styloid process of the radius at the wrist marks out with sufficient clearness the course of the radial artery, and the vessel may be tied in any part of it. In the upper third of the fore-arm (Fig. 175), between the supinator longus on the outer and pronator teres on the inner side, it can be found by an incision two inches long made in the line above mentioned, dividing the integument and deep fascia, care being taken not to divide the large cuta-

neous veins unnecessarily. On separating the muscles with the handle of the knife, the fore-arm being partially flexed, the artery will be brought into view with its venæ comites, the nerve being to its outer side. A ligature can then be easily passed round the vessel. I have had to cut down upon the radial artery in this part of its course for

Fig. 175

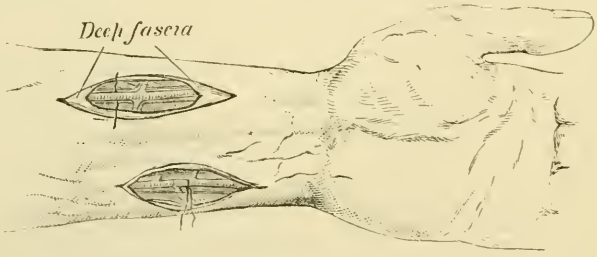


Ligature of Radial Artery.

a traumatic aneurism the result of a punctured wound; I divided the vessel and twisted both ends, convalescence speedily following.

At the lower third the vessel may be found external to the flexor carpi radialis muscle, but internal to the supinator longus. It lies beneath the deep fascia, and on the division of this the artery can readily be found (Fig. 176). On the dead subject the principal cause of difficulty in applying the ligature lies in the fact that students look for the artery too superficially, mistaking the superficial radial vein for the deep. I have had to ligature or twist the radial on seven occasions for aneurism—in six for traumatic

Fig. 176.



aneurism situated above the wrist, and in one for aneurism at the back of the wrist. In all a good result ensued.

Ligature of the Ulnar Artery.—This vessel lies beneath the superficial layer of muscles in the upper half of its course, and in the lower between the tendons of the flexor carpi ulnaris on the inner side and flexor sublimis digitorum on the outer, being covered with integument and deep fascia. Its position is roughly indicated by a line drawn from the inner side of the biceps tendon to the radial side of the pisiform bone, the upper part of the vessel describing a curve with the concavity outward.

To ligature the artery in the upper half of its course, an oblique incision must be made crossing the line above indicated, and the radial border of the flexor carpi ulnaris should be found. Through this the incision must be made, when the artery will be seen between the two layers of muscles. This operation is very difficult and uncertain, and it is an open question whether it ought to be performed. I am disposed to think that the brachial, under all circumstances, except for wound, ought to be tied rather than have recourse to it.

To tie the ulnar above the wrist is not more difficult than to tie the radial (Fig. 176). An incision along the outer side of the flexor carpi ulnaris, dividing skin, superficial and *deep* fascia, exposes the vessel, with its venæ comites, and the nerve on its inner side. A ligature can easily be passed round it. The drawings well illustrate these points.

Hemorrhage from the palm of the hand is always alarming and troublesome, more particularly when caused by a punctured wound. In a superficial incised wound the vessel may generally be found and ligatured or twisted, but in the case of a deep wound it is rarely expedient to cut into and explore for such a purpose.

When the vessel cannot be tied, a graduated compress may be applied over the wound

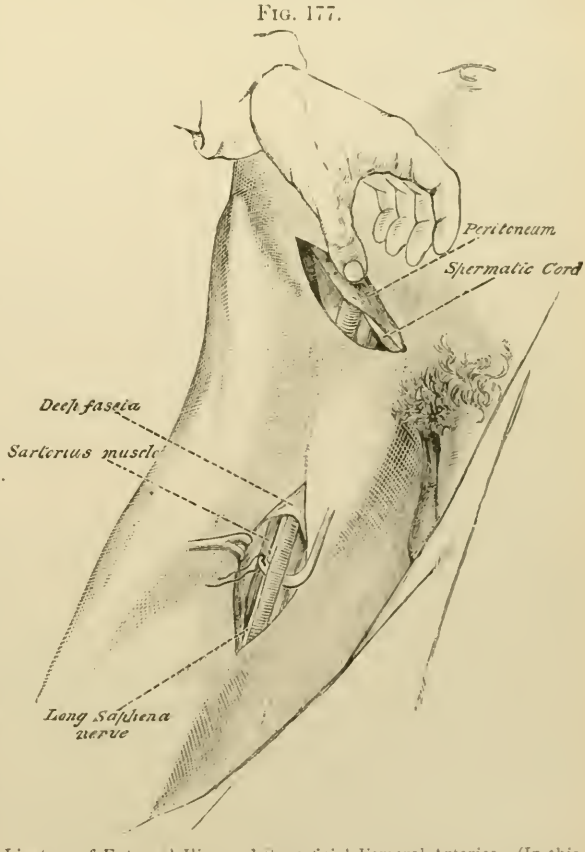
and the fingers bandaged, flexed, and bound down over a ball or block of wood, the arm being well raised in a vertical position. This dressing should not be undone for at least five or six days. If these means fail—which they rarely do when efficiently employed—the radial and ulnar arteries may be compressed with acupressure needles; and should this prove unsuccessful, the application of a ligature to the brachial artery may be required. In neglected cases, where the parts are all infiltrated and boggy, this practice may be called for at once. It is well, however, before resorting to this practice, to try extreme flexion of the fore-arm upon the arm, with forced supination of the hand, with or without a pad at the bend of the arm, as it is now well known that by this position the circulation through the brachial artery can be completely arrested; indeed, under all circumstances, whether for injury or disease of the arteries of the hand and fore-arm in which surgical interference is requisite, it would be well to remember this treatment, it being most effective. It should be known, however, that repeated hemorrhage may take place from the palm of the hand from the presence of a sloughing tendon. In illustration of this I may mention a very interesting case I had with Dr. Bunny of Newbury, where a gentleman æt. 33 had his middle finger bent back so forcibly by a cricket-ball as to cause rupture of the integument in front of the extreme joint and laceration of the flexor tendons of the finger about the wrist. Suppuration and sloughing of the tendons followed, attended by repeated attacks of palmar hemorrhage, which ceased at once on the removal of the dead tendons.

LIGATURE OF ARTERIES OF THE LOWER EXTREMITY.

The External Iliac Artery.

This operation may be required for aneurism of the common femoral artery, or for any other affection in which it is necessary to arrest the flow of blood through the lower extremity. It should not, however, be performed for any disease unless pressure of the artery, digital or instrumental, has proved ineffectual or is inapplicable, for Mapother (*Dub. Med. Press*, 1865), Eck (*St. Barthol. Hosp. Rep.*, 1866), and Hilton (*Med.-Chir. Trans.*, 1869) have all recorded instances of cure of inguinal aneurism by these means. The operation of ligature is, however, a successful one, and Norris and Cutter give 47 fatal cases out of 153 (*Am. Journ. Med. Sci.*, 1847 and 1864). I have performed it on six occasions, and in all with success. The course of the vessel is clearly indicated by a line drawn from the left side of the navel where the aorta bifurcates to the middle of Poupart's ligament, the upper third of this line corresponding to the common iliac and the lower two-thirds to the external.

Fig. 177.



Ligature of External Iliac and Superficial Femoral Arteries. (In this figure the incision for the femoral artery is placed too low.

Abernethy, in 1796, was the first to ligature the vessel. The incision he practised was vertical in the course of the artery, beginning an inch above Poupart's ligament. The peritoneum, however, is too much disturbed by this proceeding, as well as the abdominal walls weakened. The best incision is that employed by Sir A. Cooper, a slightly curved one, about half an inch above Poupart's ligament, commencing on the

inner side of its centre, curving upward and outward for about three inches toward the anterior superior spine of the ilium (Fig. 177). This incision should divide all the soft parts superficial to the external oblique muscle. All vessels that are divided should be secured.

The tendon of the external oblique muscle should then be divided the whole length of the skin wound, together with the internal oblique and transversalis muscle when they cannot be drawn outward, and care should be taken not to injure the peritoneum; the cord which then comes into view should be drawn inward and the parts held well aside by hooked retractors. With the fingers the transversalis fascia should be separated from Poupart's ligament and raised upward with the peritoneum and the sheath of the vessel exposed, the vein being to the inner side of the artery. The sheath can then readily be opened and a ligature passed, the needle being introduced between the vein and artery. To divide the transversalis fascia the whole length of the wound is an unnecessary proceeding, but to deal with it as suggested above is an extra protection to the peritoneum and in no way renders the operation more difficult; indeed, I have been led to believe that it facilitates the operation. It certainly does this on the dead subject, and in the eight cases in which I have been called upon to perform it on the living, this opinion was confirmed. The genito-crural nerve, which lies upon the vessel, should not be included in the ligature. The operation is only applicable for tumors situated below Poupart's ligament; for others, Abernethy's operation or that suggested for the common iliac should be selected.

Ligature of the common iliac artery has been performed about thirty-nine times, but only ten times with success. It was first successfully performed by Mott of New York in 1827. I have seen it done but once, and then by my colleague, Mr. Cock, in 1863, on a man æt. 27, with success.

To expose the vessel, the incision must be long, its length being determined by the size of the aneurism and the depth of the artery. A curved incision commencing outside the internal ring and passing upward and outward, as if for the external iliac artery, appears to be the best, the muscles being divided to an equal extent. The transversalis fascia must be laid open or torn through and the peritoneum turned upward. It is at this part of the operation that the greatest difficulties arise, for as soon as the transversalis fascia is divided the peritoneum covering the intestine bulges into the wound. This membrane also is frequently found adhering to the aneurismal sac, and much difficulty is felt in separating it. This was markedly so in Mr. Cock's case. The oozing of blood into the wound also masks the vessel. The depth of the wound likewise renders the application of the ligature a matter of great difficulty. Nevertheless, these difficulties can be overcome by care and good aids. The operation is similar to that last described, though more difficult. In 1846, Mr. Stanley ligatured the common iliac artery by an operation suggested by Sir P. Crampton and described by Skey. The patient was placed upon his side and an incision made from the end of the last rib downward and forward in front of the iliac crest; the transversalis fascia was divided and the peritoneum rolled up. The common iliac artery was then found and tied with apparent facility. On the dead body this operation is far from difficult, and promises to be of service to the living when the aneurismal tumor is large and high up. Indeed, it is probably the better operation of the two given. The abdominal aorta, too, could be ligatured by the same means (Fig. 169, page 383).

Ligature of the Internal Iliac.—Stevens of Vera Cruz, in 1812, was the first to perform this operation in a case of gluteal aneurism, occurring in a negress, and the operation proved successful. Since his time the operation has been repeated eleven times, and in six with success. The incision and steps of the operation are the same as for the common iliac. Stevens, however, cut down through the anterior abdominal walls, similar to Abernethy's operation for the external iliac. It should not, however, be performed for gluteal aneurisms unless rapidly increasing till other means of cure have been tried and failed, such as pressure upon the aorta or common iliac, or even galvano-puncture. Besides, Holmes has clearly shown in his *College Lectures* that in cases of imperfect or ruptured sacs either the operation of Anel or that in which the sac itself is opened should be practised.

In operating upon any of the iliac vessels it should be remembered that great variety exists as to their length. When the common iliac is long, its branches are short, and *vice versâ*.

Ligature of the Femoral Artery.

This vessel can be tied in any part of its course; and when the thigh is straight, a line drawn from the centre of Poupart's ligament to the inner side of the patella will mark out its position with tolerable accuracy. When the thigh is abducted and rotated outward, a line drawn from the same point above to the inner side of the inner condyle indicates the upper half of its course. In the upper third it is tolerably superficial; in the middle and lower, it is covered by the sartorius muscle, which varies much in its width, and by the membrane forming the roof of Hunter's canal. At the present day it is an exceptional act to ligature the vessel in Hunter's canal. For popliteal aneurism the artery is generally ligatured in the middle third of its course, at the apex of Scarpa's triangle. For aneurism of the femoral itself the common femoral may be tied below Poupart's ligament.

The **common femoral** is usually about an inch and a half in length; it does not exceed one inch in one case in four, while in one in four it is between an inch and a half and two inches (Nunn.). It is from these facts that surgeons have generally preferred to ligature the external iliac rather than the common femoral. The two Porters, however, as well as Macnamara of Dublin, have adduced sufficient evidence to prove that success may attend the practice, giving thirteen cases between them, and eleven proving successful. (*Vide Dublin Quart. Journ.*, 1860, and *Brit. Med. Journ.*, October, 1867.)

The operation, moreover, is not difficult, the vessel being readily exposed by a vertical, oblique, or transverse (Porter's) incision. The sheath of the artery is then to be opened without touching the vein—indeed, the vein should never be exposed—care being taken not to enclose the crural branch of the genito-crural nerve running down in front of the vessel in the ligature.

The main arguments against the operation are founded on the uncertain length of the artery, the proximity of the ligature to large branches, and the liability to gangrene from the occlusion of the main nutrient arteries of the limb. On the other hand, there are the success of the operation and the facility with which it can be performed. More experience, however, is required before the operation can be recommended, though it should not be dismissed without due consideration.

Ligature of the femoral artery in the middle third of its course is a capital operation, and, moreover, a successful one. Norris gives 46 fatal out of 188 operations for aneurism, or one-fourth of the cases collected from all sources, from John Hunter's first operation in 1785 down to 1848, and undertaken, too, under many different conditions. Syme informs us that he has had 23 successful cases consecutively, and at Guy's Hospital, during fourteen years, the femoral artery was tied for aneurism 24 times, with only 1 death from pyæmia and 1 failure, these cases including 6 in which pressure had been tried and failed. Pressure had been employed in 17, and in 11 with success. During the fourteen years ending 1880 the results have not been so good. Mr. Charles Symonds having shown in his interesting paper (*Guy's Rep.*, vol. xxv., 1881) that 6 cases died out of 20, or, eliminating 2 which died from causes quite unconnected with the operation, 4 out of 20; but in considering these figures it must be remembered that the ligature of the femoral artery is resorted to in the bad cases alone, in which the treatment by compression is inapplicable or has failed. Mr. Holmes, in his lectures at the Royal College of Surgeons in 1874, moreover, gives some statistics of recent hospital practice which possibly place the operation in even a better light, inasmuch as out of 77 cases of popliteal aneurism treated by ligature at once the deaths were 11, or 14 per cent., and the failures 15, or 19 per cent.; while, in 44 other cases in which the ligature was applied after the treatment by pressure had failed, 31 succeeded and 13 failed, or 29 per cent., the mortality in the latter class of cases, as might have been expected, being larger than in the former.

I may add that, of 124 cases of popliteal aneurism collected by Mr. Holmes, pressure succeeded in 66 and failed in 58. In 44 of the 58 cases the artery was tied, as seen above, 13 of these dying, and, of the remaining 14, amputation was practised in 8, death occurred in 1, while in 4 there was no evidence of subsequent treatment.

Operation.—To tie the vessel the limb of the patient should be slightly abducted and rotated outward, the leg being partially flexed and the knee supported on a pillow. The line of the vessel should then be marked by the eye and the point at which the ligature is to be applied determined, the lower part of Scarpa's triangle being the "point of selection" (Fig. 177). An incision about three inches in length must then be made parallel to the vessel dividing the integument and superficial fascia down to the deep

parts, the course of the superficial veins having previously been ascertained by making pressure upon the saphena vein where it joins the deep femoral, in order to avoid it. If the vein be in the way, the incision can be made by its side; but generally it is on the inner side of the wound. The deep fascia may then be divided and the *inner* border of the main guide to the artery, the sartorius muscle, looked for. This is readily recognizable by the course of its fibres *downward* and *inward*, and underneath this the sheath of the vessel is certain to be found. The muscle having then been gently separated from its attachments by means of the finger and held *outward* with a retractor, the sheath will be exposed with the artery in front and vein behind, the long saphenous nerve generally, and sometimes a nerve to the vastus internus, lying upon the vessel. The sheath should then be opened with caution and its inner side held tense, an opening being made sufficient to expose the vessel and admit the aneurism needle; moreover, care should be taken to keep the end of the needle close to the artery, in order that the vein may not be injured or included in the ligature. The needle ought to be passed from within outward. The ligature having been passed, the surgeon must satisfy himself that nothing but the artery is surrounded and that the vessel sought for has been exposed; he may then tie it, readjust the parts, and close the wound, covering the limb with cotton-wool and raising it on a pillow. Should the vein be wounded by the needle, it must be ligatured below the wound.

A silk ligature may separate from the femoral artery in nine or ten, or not even for thirty, days, a wide difference existing on this point, an analysis of cases decisively proving that no general rule can be laid down as to when its separation may be expected.

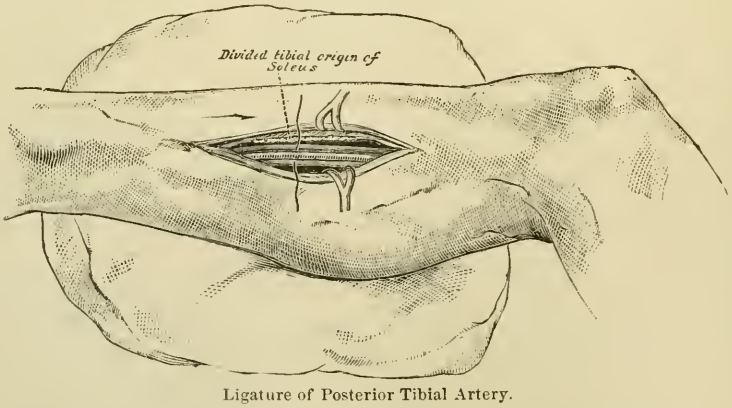
Ligature of the Popliteal Artery.

I hardly know under what circumstances the *popliteal artery* may require the application of a ligature, except for a wound, as for rupture of an artery or for aneurism the operation is as inapplicable as it would be unsuccessful. Mr. Poland has pointed out how the posterior ligament of the knee-joint is frequently involved in the laceration of the vessel. Some years ago I was called upon to cut down upon a large needle that had perforated the popliteal space and become lost in its tissues, all movements of the joint being impossible by the pricking pain occasioned. I discovered the foreign body lying obliquely across the popliteal artery with its point fixed in the posterior ligament of the knee-joint. The artery was exposed without difficulty by an incision made along the outer edge of the semimembranous muscle, the leg being extended. The vein is more superficial than the artery and can always be found to its outer side above; the nerve is still more superficial, and above still farther out, but it lies over the artery at the back of the knee and to its inner side where covered by gastrocnemius.

Ligature of the Posterior Tibial Artery.

Guthrie brought the weight of his great authority to support the recognized practice

Fig. 178.



Ligature of Posterior Tibial Artery.

of tying a wounded vessel at the wounded part even in the case of the deeply placed posterior tibial and peroneal arteries, and practically carried it out in a supposed wound of the latter vessel by making a free incision through the muscles of the calf of the leg down to the wounded artery. Arnott, also, acting on Guthrie's suggestion, tied the pos-

terior tibial by this method, though neither the report of the case (*Med.-Chir. Trans.*, vol. xxix.) nor Mr. Arnott's remarks are encouraging in any way in favor of its repetition; indeed, modern surgeons have universally rejected the method in favor of that which has now been described.

It must be premised that the vessel lies beneath the superficial layer of muscles forming the calf and beneath the deep fascia, the nerve being toward the inner side above, but to its outer side, in the greater part of its course. Its course, too, is indicated by a line drawn from the centre of the popliteal space to a point midway between the inner malleolus and the tendo Achillis.

In order to tie the artery, the leg must be partially flexed upon the thigh and made to rest upon a pillow on its outer side, the heel being raised, to relax the muscles. An incision about four inches in length should then be made about half an inch from the edge of the tibia and parallel with it, through the integument, down to the deep fascia, avoiding, if possible, any large superficial veins. The deep fascia can then be divided and the muscles exposed. The lower border of the tibial origin of the soleus muscle should then be looked for, and beneath it a director introduced; the tibial origin of this muscle should then be divided the whole extent of the wound. The glistening tendinous covering of the deep surface of the muscle is an excellent guide to the vessel and should not be mistaken for the deep fascia, which lies deeper and beneath which is found the vessel. To search for the artery, the leg must be well flexed, the heel drawn up, and the muscles retracted. The ligature can then be passed in the most convenient way.

Fig. 179.

Ligature of Posterior Tibial Artery behind Inner Malleolus.

On the dead subject this operation is not difficult, and on the living, more particularly when performed with the aid of Esmarch's bandage, it can hardly be so "difficult, tedious, bloody, and dangerous" as Mr. Guthrie has described, and as is his own operation.

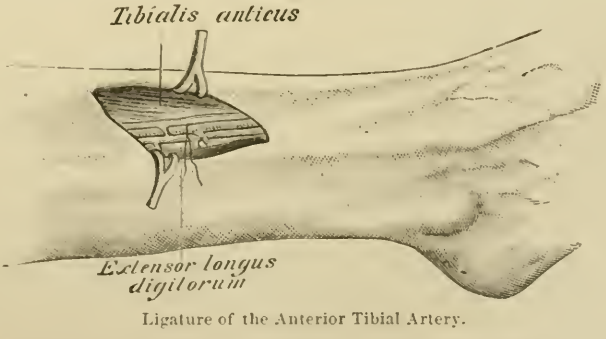
The operator should be careful, however, not to divide the tibial origin of the soleus too near the tibia, as in doing so he may penetrate the deep fascia and thus lose his best guide—viz., the glistening tendinous tibial origin of the soleus.

To tie the artery at the *lower third of the leg behind the inner malleolus* is a simple operation. It lies with its venæ comites at the junction of the anterior with the middle third of the space between the malleolus and the heel, the nerve being behind. It can readily be exposed by a curved incision two inches long over the course of the vessel, dividing integument and *deep* fascia, which is thick from receiving many fibres from the internal lateral ligament. The relative position of the vessel can easily be seen in the drawing (Fig. 179).

Ligature of the Anterior Tibial Artery.

This operation is far from simple, inasmuch as the vessel lies buried in the upper two-thirds of its course between the muscles on the interosseous membrane; its course

Fig. 180.



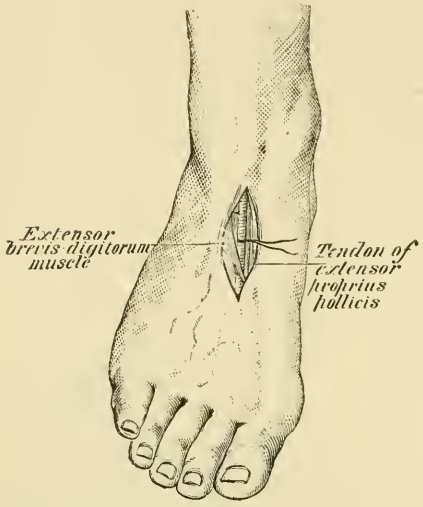
Ligature of the Anterior Tibial Artery.

is indicated by a line drawn from the inner side of the head of the fibula to the base of

the great toe. The surgical guide to the vessel is the tibialis anticus muscle, which *lies to its inner side* throughout its course.

To reach the vessel in the upper two-thirds of its extent, it is important to expose the intermuscular space separating the tibial muscle from the extensors communis digitorum and proprius pollicis; and the best way to accomplish this is to make an oblique incision four inches long, commencing at the outer edge of the tibia and directed downward and outward toward the external malleolus, dividing the integument and superficial fascia. The deep fascia will then be exposed, and the first white line external to the tibia will be found to mark the intermuscular space outside the tibialis anticus muscle in which the anterior tibial artery is to be found. The fascia over this line may then be opened and the muscles separated, the foot being well flexed to facilitate this measure. The anterior tibial nerve will then come into view, and beneath it the artery will be found. The ligature may be passed as best can be done.

Fig. 181.



Ligature of Dorsalis Pedis Artery.

Ligature of Dorsal Arteries of the Foot.

The dorsalis pedis artery should be ligatured to the outer side of the extensor proprius pollicis muscle, by the side of which it lies. The vessel can readily be exposed by an incision made along its course, the integument and *deep* fascia being divided (Fig. 181). It is crossed at its lower part by the tendon of the extensor brevis digitorum muscle, and the nerve lies outside the vessel, while venæ comites attend the artery. The tendon of the last-named muscle is an infallible guide to the artery, as it crosses it, whilst the tendon of the extensor proprius pollicis muscle is the guide to the incision. The surface line of this vessel extends from the middle of the joint of the ankle to the base of the first metatarsal space.

CHAPTER XI.

INJURIES AND DISEASES OF THE VEINS.

The blood from a wounded vein is black, flows in a steady stream, and never jets out as from an artery. When mixed with arterial blood, as occurs when both artery and vein are punctured, it appears as a dark band streaming through a red, or *vice versâ*, the relative thickness of black or red band indicating the extent of the wound in the artery and the vein. Pressure on the distal side of a wounded vein controls bleeding, whilst pressure on the cardiac side increases it.

Wounds of veins unite as do wounds of arteries, the reparative process being alike in both. After a clean incision into a vein repair may be so perfect in a few days as to leave no trace of injury behind. The lips of a wound in a vein readily unite—as after venesection—when kept together by gentle pressure or the application of a ligature.

A completely divided vein *contracts*, though somewhat less than an artery; it also *retracts* into its sheath, and the natural arrest of hemorrhage is helped by these actions, together with the coagulation of the blood in the vein and around its orifice. But these processes are slow in their action, very feeble, and practically insufficient. Fortunately, however, hemorrhage from a divided vein is easily arrested by well-adjusted pressure and by elevation of the limb. After amputations, if venous bleeding persist on the removal of the tourniquet, and should the means just indicated have failed, the bleeding vein may be acupressed, ligatured, or, what is better, twisted.

A partially divided vein often gives much trouble, although not when *superficial*, because the elevation of the limb and a compress carefully strapped or bandaged over the wounded part are generally sufficient to check the bleeding, and in three or four days repair may be completed.

Wounds of deep veins, however, are of grave importance; and when the veins are large, they are as serious as wounds of large arteries, and unhealthy inflammation of the vein with all its dangers may follow.

Treatment.—In wounds of any of the veins of the extremities well-applied pressure is, as a rule, sufficient to arrest bleeding and give time for repair; when the trunk of the femoral vein is wounded in operation, as in ligature of the femoral artery, the vein should be divided and tied with a fine prepared catgut ligature. The same should be done to a punctured wound of the internal jugular or any large vein. To tie the opening in the vein is now known to be an error. Wounded veins, indeed, should be treated on the same principles as wounded arteries. When pressure is enough to arrest hemorrhage from a vein, however large, the ligature is not required; but when it fails or is inapplicable, the ligature may be fearlessly employed. The dread of setting up phlebitis by ligaturing veins is based on prejudice, and not on experience; it is doubtless due to the influence of authorities who have pronounced against it. It cannot, however, be disputed that phlebitis occasionally follows the surgical treatment of veins. When it occurs, the affection is serious, and takes place only in the enfeebled and cachectic.

Wounds of the **internal jugular and subclavian veins** are as fatal as, and probably more so than, wounds of the carotid or subclavian arteries. When the internal jugular is wounded near the base of the skull, life is speedily destroyed; and when near its cardiac end, to the danger of hemorrhage is added that of the introduction of air into the heart. When the internal jugular is divided *above* the clavicle, the orifice remains open, the walls not collapsing, as they would at a greater distance, owing to their connections with the deep cervical fascia; reflux bleeding consequently takes place from the cardiac end, and during some violent inspiratory act air may be drawn into the circulation and into the heart, causing death. Hence great care is always required in operating about the root of the neck to avoid large veins, and to compress or ligature them when wounded.

When death takes place from primary hemorrhage from the internal jugular, it is generally within an hour. I recorded in the *Trans. of Path. Soc.* in 1857 such a case, which occurred in the practice of Mr. Birkett; a second was recorded by Mr Henry Gray in *Holmes's Surgery*, and a third by Mr. Samuel Cooper in his *First Lines of Surgery*.

When death does not supervene from either of these two causes, it may occur from secondary hemorrhage or from pyæmia.

A vertical incision into the internal jugular vein is not necessarily attended with a fatal hemorrhage. When bleeding occurs, it will be recurrent. This was well illustrated in a case recorded by Mr. Woodman of Exeter (*Brit. Med. Journ.*, 1873), in which the internal jugular vein was ligatured with a successful result.

Coagulation in Veins.

Adhesive Phlebitis.—When a vein was found by the older surgeons obstructed by a fibrinous clot, the suspicion of phlebitis was excited; and when this clot contained in its centre a "puriform" fluid, the evidence of inflammatory action was considered to be strong. When the clot was more or less adherent to the inner membrane of the vein and this membrane presented a pink appearance, the evidence was thought to be complete. At the present day, however, none of these phenomena are accepted as true indications of an inflamed vein, as it is known that blood coagulates spontaneously in a wounded, lacerated, or bruised vein, that it does so when the venous blood is stopped circulating from pressure upon its walls or from inflammatory or ulcerative changes in the parts around, and that in ill-nourished and cachectic subjects there is a remarkable tendency for the fibrin of the blood to become deposited upon the serous lining of the veins, either idiopathically from some altered condition of the blood or on the slightest injury, without the existence of inflammatory action.

The supposed pus found in the centre of the fibrinous mass is known to be made up of the white blood corpuscles present in all coagula, while the pinkish tint upon the serous lining of the vein is due to the mere imbibition of coloring matter from the blood, and not to inflammatory injection.

A clot once formed in the vein rapidly increases, the stream of blood as it flows over it depositing fresh layers, until the whole calibre of the vein is obstructed. When the process is slow, regular layers of fibrin may be seen in section; but when rapid, the clotting is irregular. At the extremities of the clot, also, like accretions are deposited; the coagula increase more or less rapidly in all directions and into all branches, till complete obstruction or THROMBOSIS, takes place. This clotting of blood in the vein becomes arrested only by the blood stream of a junction trunk. These coagula can readily be removed by washing; and when removed, the lining membrane of the vein will generally be found natural and the valves visible. The coat of the veins at times may appear thickened from contraction, but Mr. Callender has shown that this is not a real, but only an apparent, condition, the coats of the veins readily yielding to pressure under water. In the process of cure sometimes the clot will contract toward one side of the vein, thus allowing the blood to pass and the circulation to become re-established. In rarer cases the blood "may drill for itself a passage through the centre of the clot." In many, again, the clot will eventually disappear and the vein become patent. Ordinarily, however, a different result takes place; the vein becomes permanently obliterated, the clot and vein ultimately contracting so as to form a firm and shrunken cord. In rare cases the clot may subsequently organize. Authors have described these as instances of *adhesive phlebitis*. In feeble and cachectic subjects, however, these curative changes cannot take place. The clot, instead of organizing, will soften and disintegrate, giving place to blood-stained puriform fluid that may be carried into the pulmonary circulation, causing a lobular pneumonia such as is found in pyæmia from embolism of the pulmonary artery. This was well illustrated in the following case, extracted from the catalogue of the Guy's Museum, No. 1521[55]: Jugular vein exhibiting a wound occupying about half its circumference and situated about half an inch above the subclavian, the neighboring branches showing the effects of phlebitis. James F——, æt. 30, under Mr. Birkett. He received a stab with a knife in the left side of the neck which wounded the jugular vein; much hemorrhage followed, and continued for some days, when symptoms of phlebitis set in, and he died of pneumonia twenty days after the accident. The vein was found to be wounded, as seen in the preparation, its coats infiltrated with lymph, and its interior filled with fibrin. The lungs were filled with abscesses.

Results such as these, however, do not occur under all circumstances, but only in the feeble and cachectic; for "the clot, when softened, is usually shut off in an upward-and-downward direction by newly-added coagula. The softening begins in the coagula last formed, and not, as Virchow states, in those first deposited; for in the advance of the malady the patient's health fails and the fibrin becomes more and more prone to disintegrate and soften into a puriform fluid" (Callender). The clot softens also in the centre, and not at its periphery; and such cases have been described as examples of *suppurative phlebitis*.

SYMPTOMS.—The most prominent symptoms of an obstructed vein are œdema of the parts below the obstruction, some fulness of the superficial veins, with local pain and tenderness, constitutional disturbance of variable degrees of severity generally preceding. When superficial veins are involved, the symptoms may be chiefly local, but in the case of deep veins constitutional disturbance is sure to accompany local action. Among the superficial veins the saphena of the leg and thigh is most commonly affected, and is often a sequela of a varicose condition. Under these circumstances, the tortuous, dilated, indurated vein becomes a marked object, set, as it were, in a frame of hardened, inflamed skin and cellular tissue. The parts themselves will to a certainty be painful, and the pain and tenderness probably extend up the thigh as far as the groin. Among the deep veins the common femoral or iliac is more frequently involved than any other, and what is known as a "white leg" is due to this affection, it being an œdema of the leg from an obstruction to the femoral or iliac vein, with local pain and tenderness and more or less constitutional disturbance. In some cases the phlebitis is of a very mild character, and then a good result may be anticipated; but in others it is very severe, and in such suppurative changes will probably take place.

It sometimes happens that a limb becomes much enlarged and solid in the deeper but not in the superficial parts—that is, no œdema of the cellular tissue beneath the skin will be present, although the superficial veins may be turgid. The absence of this symptom, however, must not mislead, as it simply indicates that the superficial circulation is efficiently carried on and that no stagnation exists sufficient to allow of passive serous exudation.

When these cases proceed favorably, the swelling will gradually subside, as will also

every other symptom, the vein either recovering its normal condition or the blood finding its way through other channels. When they go on unfavorably, suppuration will take place; and if the deep parts are involved, the case assumes a very serious aspect, as a local or a diffused abscess may result (the latter condition being the more common), and then blood poisoning too frequently ensues with its usual consequences.

TREATMENT.—The two great indications for treatment in these cases are (1) *to favor the venous circulation of the part*, and (2) *to improve the general condition of the patient*.

The first can be attained by elevation of the limb, the foot being raised higher than the hip, and by the application of warmth to the part in the shape of fomentations or cotton-wool.

The second can be carried out by the administration of a simple nutritious diet, tonics, such as quinine, bark, or iron, and stimulants carefully adjusted to the wants of the individual case.

Pain must be allayed by both local and general means, as poppy fomentations and the internal use of opium, morphia, or chloral.

Leeching should never be resorted to, nor mercury in any of its forms, as the practice was based on a mistaken pathology, and therefore should be discarded.

When suppuration appears, it must be dealt with on ordinary principles, as it is wise, as a rule, to evacuate it as soon as it has declared itself.

Gouty Phlebitis.—Subjects who are gouty from hereditary or acquired causes are likewise liable to *adhesive phlebitis*. Sir J. Paget has well described the affection in his *Clinical Lectures* (1875), and Mr. Gay has also written ably upon it (*Lancet*, May 19, 1877): "In such cases the phlebitis may have no intrinsic characters by which to distinguish it, yet not rarely it has peculiar marks, especially in its symmetry, apparent metastases, and frequent recurrences."

Like other forms of phlebitis, it is more common in the lower than in the upper extremities, yet it may be found anywhere. It affects, however, the superficial rather than the deep veins and often occurs in patches, affecting on one day (for example) a short piece of the saphenous vein, and the next another piece of the same, some other distinct vein, or a corresponding piece of the opposite vein.

The inflamed portions of vein usually feel hard and are painful to the touch. The soft parts covering the vein become slightly thickened and often have a dusky reddish tint. When the deep veins are involved, œdema appears, with the well-recognized results of venous obstruction: "the limb becomes big, clumsy, featureless, heavy, and stiff; its skin is cool and may be pale, but more often it has a partial slight livid tint, which might be discerned by comparison with the other limb, and has mottlings from small cutaneous veins visibly distended." The limb thus enlarged feels œdematous throughout, but firm and tight-skinned, not yielding easily to pressure, and not pitting very deeply.

By almost this state alone the disease can sometimes be recognized.

The CONSTITUTIONAL SYMPTOMS associated with this local affection vary from some slight febrile condition to those met with in acute gout. Complete recovery may take place in this as in other forms of phlebitis, the veins becoming pervious in some cases and obstructed in others, the limb reassuming its healthy condition or becoming permanently enlarged, cumbrous, and heavy. The risks of embolism are also the same.

TREATMENT.—Nothing special can be recommended, as the so-called gout remedies do not appear to have much influence on the local disease. Rest, elevation of the limb, lead lotion to the inflamed vein when superficial and fomentations when deep, are the chief points to be attended to in the local treatment, and a lower diet, abstention from stimulants, and saline drinks in general. When feebleness exists, the liquor ammonia in doses of five to ten drops with bark is an excellent remedy, but at others quinine is called for.

Suppurative Phlebitis.—There is, however, another form of phlebitis that must be mentioned, and which is by far the most serious—viz., the *unhealthy diffuse or suppurative phlebitis*. It is an affection of the cellular tissue around the veins, these veins themselves being secondarily involved. It is a species of erysipelatous inflammation of a low type, and it is only found in the feeble and cachectic. It comes after a severe injury to or operation on bone; after a slight contusion or a severe wound; it may supervene on the puncture, division, or ligature of a vein, or chronic suppurative disease, more particularly of the bones of the cranium. It occurs also in the puerperal state. Depending upon a vitiated condition of the blood, "we are able to appreciate how it is that the many different forms of phlebitis may follow various dissimilar injuries, and reconcile the fre-

quency of their occurrence after operations involving the venous system. The dangers are not to be looked for when the general condition of the system of the individual is good and when the walls of the vessels are in a healthy state, but they may be anticipated in enfeebled and broken-down constitutions, more particularly when the coats of the vessels are abnormally changed. Upon such a class of persons operative procedure should, therefore, if possible, be avoided" (Dr. S. W. Gross, 1867).

Local Symptoms.—The disease shows itself as a purulent infiltration of the cellular tissue surrounding the vein with a thickening and softening of the coats of the vein itself. As the disease progresses abscesses form around the vein, whilst the circulation through it is arrested by the formation of coagula in one spot and a sloughing abscess in another. In superficial veins, such as in the leg, all these changes can be well observed, but in the deep they are difficult to diagnose. In the superficial the external signs of inflammation are well marked, local redness and brawniness of skin around a dilated, thickened, and tortuous vein being the chief symptoms. As the disease progresses local abscesses appear in the vein itself, which yield blood and pus on being opened, these contents being, doubtless, broken-down coagula.

Constitutional Symptoms.—The constitutional symptoms vary with the extent and severity of the disease, marked depression of the general powers always being present, while rigors not only usher in the attack, but attend its progress, each one probably indicating some suppurative change. Local pain and sleeplessness are common accompaniments, and in cases that cease to be local and have an infective tendency those known as typhoid symptoms occur. When blood poisoning or pyæmia appears, the symptoms are such as have been described in an early chapter.

On the Presence of Air in Veins.

That air may find its way to the heart through an open vein and cause sudden death is a clinical fact with which all surgeons should be familiar, also that this entrance generally occurs during the removal of tumors about the neck and axilla, amputations at the shoulder-joint, and operations or wounds involving the cervical or other veins. It has likewise occurred in uterine surgery from the injection of air or gas, etc. Two-thirds of the patients affected die from the accident, half within a few minutes, others living hours or a few days. The accident is favored by a thickened state of the vein, and is generally indicated during the progress of an operation by a sudden gurgling, hissing, or bubbling sound in the wound, associated with venous bleeding, sudden faintness, and insensibility of the patient, or convulsions, probably terminating in death. When this result does not at once transpire, there will be labored and irregular respiration, tumultuous action of the heart, and feeble pulse, the lividity of the patient gradually disappearing, the heart then regaining its natural action, and the patient recovering. Bubbles of air may at times be seen in the wound. In some cases the patient will give a sudden cry with the first onset of the symptoms.

After death evidence of the admixture of air with the blood has been found in the form of bubbles in the vessels of the brain or in the large venous trunks and arteries. In some cases air has been found in the right cavities of the heart. Where a suspicion of this cause of death exists, the heart and large vessels should be opened under water, to make manifest the escape of air-bubbles, one single bubble indicating air in the heart, and many bubbles air in the vessels. Experiments on animals by Erichsen and by a French commission tend to confirm this observation.

Treatment.—How to deal with these cases has now to be considered, and, without doubt, preventive are more important than curative measures. In dealing with large veins, or, indeed, any veins near their cardiac ends, the surgeon should be careful to apply pressure and to maintain it during the operation, while in some instances it is more expedient to ligature before dividing or twisting them. When the bubbling sound has been heard, pressure must at once be applied to the spot where the bubbles appear. When a large vein has been wounded by accident, it should be tied; and when this cannot be done, the opening must be taken up by forceps and carefully closed with a fine silk ligature.

When air has been admitted into the heart and its action interfered with, the surgeon's aim should be to keep up its action and help the respiratory act by artificial means, such as by cold water on the face and thorax, stimulants, as ammonia to the nostril, etc. Amussat ascribed recovery in one of his cases to pressure upon the chest, leaving the opening in the vein free, so as to allow of the escape of the admitted air; but in adopting this practice care must be observed to close the orifice of the vein in the inspiratory act. Brandy

and diffusible stimulants should also be freely given, to sustain and stimulate the vital organs.[1]

Hypertrophy and atrophy of veins occur in precisely similar circumstances as hypertrophy and atrophy of other structures. Thus where increase of function of a part exists, or increased growth, the veins will elongate, dilate, and thicken. When decrease of function or disease of a part takes place, the veins waste or become atrophied with other structures. Hence, after amputation of the thigh, the femoral artery and vein become as small as the anterior tibial; and in Mr. Cock's case of arterial varix, related in page 375, the vein above the varix withered to a mere cord. On the other hand, in the same case of arterial varix, the popliteal vein below the varix, when taking on the action of an artery, become much enlarged and thickened—in fact, hypertrophied—simply on account of the increase of work it had to perform under its new condition, and the superficial cutaneous veins through which the whole of the returning blood must have passed became enormously enlarged. An equally good instance of hypertrophy of veins can be seen when any obstruction occurs to one of the cavæ or any large venous trunk, the venous circulation making its way through other channels, which consequently enlarge. Thus, in Fig. 182 the skin veins of the abdomen and chest are seen to be enormously distended and hypertrophied to carry on the circulation from the lower part of the body to the heart, the lower vena cava having been completely obstructed from cancer-disease. The woman, æt. 47, a patient of Sir W. W. Gull, had no œdema of the lower extremities all through the case, thus proving the perfection of the compensatory venous collateral circulation, and probably indicating the gradual progress of the obstruction.

Fig. 182.

Collateral Venous Circulation. (Taken from a woman æt. 47, under the care of Sir W. W. Gull, in whom the inferior vena cava was completely obstructed from cancer. Guy's Hosp. Mus., Drawing 44[0].)

Calcareous and atheromatous diseases of the coats of veins may occur, but are rare affections when compared with their frequency in the arteries. In Guy's Museum (1538[25]) there is a good specimen of ossified saphena vein, and at St. Thomas's Hospital and the College of Surgeons' Museums may be found examples of calcareous degeneration of other veins. Gay has also described a dissection of a varix which "appears to have been occasioned by disease, originally atheromatous, followed by softening and ulceration of the inner and middle tunics of the vessel," and Mr. Pick of St. George's Hospital (*Path. Trans.*, 1867) has given a somewhat similar example. How far, however, this atheromatous and calcareous degeneration is a distinct disease, or an "after-change in some local deposit of fibrin," is an open question.

Varix.—Varicose Disease of the Veins and Phlebolithes.

The term "varicose vein" is unfortunate, as it is applied to any enlarged tortuous vessel, to such as have been already described as hypertrophied veins, and to others that are clearly due to some diseased action resulting in hypertrophy with dilatation. In the sequel the term will be confined to the latter condition. Varix is commonly an affection of the veins in the lower extremities, and mainly of the branches of the saphena vein. When it involves the submucous veins of the rectum it is called a hemorrhoid, and when the veins of the spermatic cord a varicocele. But "all the veins of the body may become varicose," said M. Briquet in 1824. In 1869 a child æt. 4 was brought to me with a saculated varix the size of a nut connected with a vein on the outer side of the right forearm; it had been coming on for a year and a half. Taking varix of the lower extremity as a type of the affection, it appears as a disease involving one or more, and in extreme cases all, of the branches of the saphena vein. In most instances it is confined to the larger trunks; in some it spreads to the smaller tributaries.

In some, however, the affection appears to begin in the capillaries of the skin and to spread toward the larger trunks, and such cases are most common in women. They appear

[1] The reader may refer to an admirable paper on this subject by Dr. J. S. Green of Massachusetts, *Amer. Med. Journ.*, 1864.

as "clusters of diseased venous radicles" (Gay) and rarely involve other than the smaller branches.

It must not be thought, however, that this affection is one of the superficial veins alone, for such is not the case. Boyer asserted this many years ago, and on his authority the opinion has been accepted. Verneuil corrected the error, and in the *Gazette Hebdomadaire et Médicale*, 1855, showed that varix is as often a disease of the deep veins as of the subcutaneous, the latter often indicating the existence of the former. He believed, moreover, that the intramuscular veins are sometimes affected without the subcutaneous. Hilton, and more recently Callender, have told us that the varix of a subcutaneous vein is found wherever the intramuscular veins pass into the subcutaneous, mentioning that "the valves obstruct below and the column of obstructed, slow-moving blood resist above." Callender has failed, however, to confirm Verneuil's remarks, that varix of the intramuscular branches is constant.

Mr. Gay, an able author on varicose veins (1868), concludes from his experience of many dissections that "with superficial varicosity there are other serious lesions affecting both arteries and veins, deep and superficial, such as would lead to the conclusion that the general circulation has been subject to a very considerable and long-standing embarrassment, some incompetency of the arterial system or impediment to the venous, or both combined;" and these conclusions are probably correct.

The CAUSES of varicose disease of the vein are obscure. Surgeons of the past regarded such affections as the invariable result of some obstruction to the venous circulation, such as prolonged standing, the presence of abdominal or pelvic tumors, pathological, fecal, or fœtal, patients of a relaxed and feeble habit naturally suffering more than the robust; and in a measure, doubtless, their opinions were correct. Mr. Herapath of Bristol maintained that the cause of varix was the narrowing of the saphenous opening of the thigh, and cases are on record where its enlargement seemed of value; facts, however, are wanting to support this view. General testimony also admits that this disease is as common in the higher as in the lower ranks of life and in women as in men; that it is as frequent on the right as the left side, and more frequently on both; that it is a disease of the young as much as of the middle-aged; that it is met with in the strong and healthy as well as in the feeble and cachectic; in fact, it is found under every condition of life and in every variety of subject. Some evidence exists that gout and hereditary predisposition are efficient causes, with local injuries and prolonged muscular exertion.

The SYMPTOMS vary according to the place of its origin. When it commences in the venous capillaries—its common seat in women—it appears as a fine capillary injection giving an arboreseent appearance to the skin, with more or less congestion, and as it extends the larger venous trunks become involved, the main trunks being rarely affected.

When it originates in a large trunk, the varix may appear as a fusiform enlargement or a simple dilatation of the whole length of the vein. In some there will be thinning of the venous coats, in others a thickening, whilst in a third class one part will appear thin and another thick.

Again, the affected vein becomes tortuous and knotted to an extreme degree, and it is far from unusual to find it the diameter of a finger (Fig. 183). The valves of the veins under these circumstances are clearly lost—not, however, from a yielding due to backward pressure of the column, but from their action being rendered imperfect by the dilatation of the vein behind; the "valve cusps, being unable to meet and close the canal, shrink and atrophy."

FIG. 183.

Varicose Veins. (From a patient of Mr. Jacobson).

As the disease progresses the tissues around the affected vein become gradually absorbed; the skin is thinned, and even the bone grooved, the skin, indeed, becoming so thin as even to rupture; and a fatal hemorrhage is far from being a rare result. At Guy's during the last few years several cases of this sort have taken place. Subcutaneous rupture of the vein may at times occur, of which I saw a severe instance in a man, æt 62, in 1858. More frequently, however, the soft parts around the diseased vein thicken or inflame. They thicken from a kind of passive exudation into the cellular tissue, the result of impeded venous circulation, and give rise to a slightly anasarcous condition of the part, which in chronic cases becomes somewhat permanent, producing what Liston so well described as a "solid œdema." In extreme instances this solid œdema is so marked as to give rise to appearances similar to the disease called "elephas," or Arabian elephantiasis.

On the other hand, it is a very common result for the cellular tissue

around the vein, and probably the vein itself, to inflame. The parts around the varix or tortuous vein become indurated, red, and painful. In healthy subjects this inflammation may end as an adhesive one (local adhesive phlebitis) and in the feeble as a suppurative, local or diffused abscesses subsequently showing themselves. When the powers of the patient are very low or blood poisoning takes place, that terrible disease unhealthy suppurative phlebitis, previously described, may ensue.

In the early period of the disease an aching of the limbs on standing or after exercise may be the only symptom, a local pain occasionally indicating the seat. In a more advanced period œdema around the ankle may be observed.

When the femoral vein becomes dilated where the grand venous junction takes place at the saphenous opening, the swelling may on a careless examination be mistaken for a *femoral hernia*; for both will disappear on the patient assuming the recumbent posture, and reappear on his coughing. There is, however, this point of distinction—that, while by local pressure on the crural ring a femoral hernia can be kept in its position, a femoral varix can be made to enlarge.

As a secondary result of varicose disease the blood in the vein may coagulate, giving rise to *thrombosis*; and this coagulum may break up, causing a local abscess, or it may wither and organize, causing occlusion of the vein, and consequently a partial cure. There is reason, also, to believe that this may dry up and become so altered as to form what are known as *phleboliths*, as these have a laminated character, and in Dr. Franklin's analysis are said to be composed of protein matter and phosphate of lime, with a little sulphate of potash and lime.

With varicose disease of the veins there is very frequently associated an eczematous condition of the leg, the eczema being apparently due to the feeble venous circulation of the part. If this eczema be neglected, a superficial ulceration of the skin may ensue; and if no attention be paid to this condition, the ulcer becomes chronic. But beyond this no special form of ulcer can be said to exist as a result of varicose veins; in fact, there are no "varicose ulcers." In practice every variety of ulcer is found associated with varicose disease, and the existence of the latter doubtless renders the repair of the former somewhat more difficult. Thus it appears that chronic indolent sores associated with varicose diseases have been termed "varicose ulcers."

Treatment.—Varicose disease of the veins in its early stage is very amenable to treatment, but later on none are more obstinate, the patient being only relieved, and rarely cured. Happily, however, under common care it never threatens life.

When the affection is first discovered, the local treatment must be directed to assist the venous circulation by the raised position of the limb, the patient being recumbent; friction, too, should be steadily applied upward; all sitting, standing, or walking should be strictly prohibited; and when possible, this treatment should be persevered in for three or four weeks. When exercise is allowed, steady pressure by a well-applied bandage from below upward should be maintained or an elastic stocking worn, and in the course of time, the extent of which greatly varies, a cure may be effected and maintained.

During this time the general treatment must not be neglected. Where the powers are feeble tonics must be given, and of these iron is the best, twenty drops of the tincture of the perchloride, with ten of the tincture of nux vomica and a drachm of glycerine in water, being an excellent compound.

A generous diet must be given when indicated, and the reverse where the portal system has been overgorged by excess. Mild aperients are always of value under these circumstances, salines being preferable to the purgative extracts. The natural waters are of great value.

When rest cannot be given, well-applied pressure must be relied upon, the best forms being a pad of cotton-wool over the part, with a bandage of Domett elastic tissue or pure rubber applied from the toes upward. The patient must be impressed, however, with the necessity of assuming the horizontal position as much as he can, aiding the circulation by friction, as already indicated, and by general treatment. The bandage should always be put on before the legs are moved off the bed and removed only after the recumbent position is again resumed.

In bad cases of local varix the pressure may be more local and permanent, a pad of cotton-wool well fixed on by strapping being very valuable. When the veins are inflamed, they must be treated on principles already laid down in the chapter on phlebitis.

If a vein burst, bleeding can be controlled by the application of a finger to the spot, and any further flow is prevented by the elevation of the limb. A pad carefully adjusted

to the bleeding point and fixed by strapping applied like a bandage or by a roller makes the patient safe.

Operations for Varicose Disease of the Veins.

It has been observed that nature not unfrequently obliterates a varicose vein by means of a coagulum which subsequently contracts, and even organizes, the clot and vein together forming an impervious cord. Acting on this knowledge, surgeons now endeavor to make use of nature's processes, and by artificial means to induce coagulation of the blood in some portion of the varicose vessel, with the hope that it may contract or so to destroy some part of the vein itself as to compel the circulation to find another course. This is the so-called "radical cure," but it is to be thought of only, as Mr. Gay so truly says, when the vein is hopelessly deteriorated or so inflamed and painful as to threaten to burst, or in cases in which all palliative and other treatment is inapplicable or has failed.

Caustics were employed by Mayo for this purpose, and also by Brodie, Key, and others. They should be thus applied: A small piece of Vienna paste (composed of four parts of potassa fusa and four of quicklime, made into a paste with spirits of wine prior to its application), or chloride of zinc paste of the size of a small pea, should be applied upon the vein, the surrounding skin being previously protected by a ring of plaster carefully adjusted; the paste should be fixed on and left, the object being to cause a slough through the tissues into the vein. This slough should not be large, but three, four, or more applications may be simultaneously made about an inch apart, in order to guarantee success. The caustic may be left for twelve or twenty-four hours and then removed, water dressings being afterward applied to the part. During all this treatment the patient must be kept in bed with the limb raised. I cannot, however, recommend this treatment.

Subcutaneous division of the vein was practised by Brodie, but after some experience he came to the conclusion that "it really appears it is not worth patients' while to submit to it."

Excision of a portion of the diseased vein has likewise been employed with success, and where an operation is called for it is doubtless the best. My colleague, Mr. Davies-Colley, in 1874 reintroduced the practice (*Guy's Hosp. Rep.*, vol. xx. series iii.), which has been followed by myself in bad cases and others. The operation, which is a good one, consists in the exposure of the varix by a free incision and its removal after the application of a carbolized catgut ligature to the trunk of the diseased vein above and below. Mr. Marshall in 1875 adopted a like practice (*Lancet*, June 23, 1875), taking away some inches of diseased vein with forceps and scissors after having isolated the portion to be removed by means of pins passed under the vein above and below.

Another operation much favored and practised is that of *acupressure*. It is performed by passing a pin beneath the vein, but not through it, as in Davat's plan, and obstructing the circulation through the vein by means of a twisted suture either of silk, india-rubber, or wire applied round the pin, or by a piece of thin india-rubber stretched across it on the pin, as suggested by Mr. Lee. Two, or even six, of these acupressure needles may be inserted about an inch or an inch and a half apart, according to the extent of the disease. Mr. Lee employs, also, the subcutaneous division of the vein between the pins at the same time, and my own experience confirms the wisdom of this practice. Mr. Wood employs an elastic steel spring to keep up tension on the ligature till it cuts its way through the vein.

On several occasions, having obstructed the circulation through the vein as already described, I have injected the vein between the pins with perchloride of iron, one drop being generally sufficient to cause coagulation of the blood; in others I have used a concentrated solution of tannin; and in all a good result ensued. The syringe should be that used for hypodermic injections.

The time for withdrawal of the pins varies according to the effect intended to be produced. When inserted to induce coagulation of the blood only, and not inflammation, they may be withdrawn on the third or fourth day, and in the practice suggested of acupressure and injection this plan should be followed. Sir W. Fergusson states: "They should be left until they have excited considerable swelling and slight ulceration, and in some instances, where the former is not very conspicuous, they may be permitted to separate by ulceration through both vein and skin. I recommend that the process of inflammation should be more implicitly relied upon than that of coagulation." He adds, moreover, that he has not met with any seriously unpleasant effects out of the numerous instances in which it has been employed.

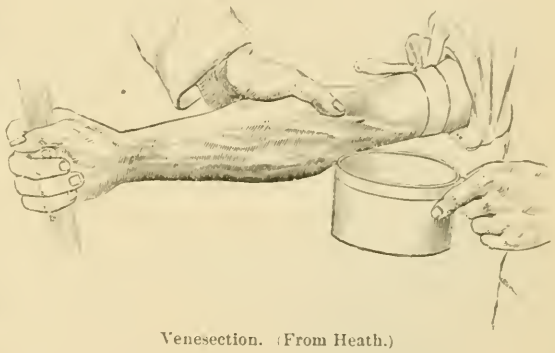
It must be repeated, however, that these operations should be practised only in extreme cases, and not where palliative treatment is applicable. When a vein threatens to burst or has burst and endangers life, surgical treatment is justifiable.

Mr. Gay called attention (Lond. Med. Soc., October, 1871) to a class of cases in which the superficial or complementary veins, as he calls them, are obliterated, and as a result the return of the venous blood is carried on entirely by the deep veins. These consequently become diseased, the circulation through them grows feeble, and degeneration of the tissues ensues, associated with deep-seated solid œdema of the limb, not subcutaneous œdema, which belongs to obstruction only in the subcutaneous veins. For this disorder exercise, warm applications, tonics, etc., are required, but bandages and rest do harm.

Venesection.

At the present time this operation is very rare indeed, and at Guy's Hospital it is as rare as, if not more so than, amputation. Forty years ago it was one of the most common, and there seems some reason to believe that it will soon be practised again with greater frequency, especially when we find Sir James Paget asserting "that we undoubtedly overvalue the blood and estimate too cautiously the loss of it:" that "the loss of blood up to fainting, and in some cases I remember with those epileptiform convulsions that come with the loss of blood, is absolutely harmless"—that is, when performed upon a large series of healthy persons, as was the custom in his student days (*Lancet*, August 15, 1874).

Fig. 184.



Venesection. (From Heath.)

It is not a difficult operation, but requires nicety and care. It is usually performed at the bend of the elbow. The first thing the surgeon has to do is to render the veins prominent by arresting the circulation through them by means of a piece of broad tape or narrow bandage carried twice round the arm a few inches above the elbow and tied in a bow, but not tight enough to stop pulsation in the arteries (Fig. 184). He then selects the vein, the largest being the best. Where the outer vein or median cephalic is of good size, it should be chosen, as the inner or median basilic lies immediately over the brachial artery: either, however, may be selected, care being observed not to go *through* the vein. He should also assure himself that no malposition of the artery exists, as many cases are on record where a superficial artery has been opened for the vein.

Fig. 185.

After Venesection. From Heath.

The vessel, then, having been selected, the surgeon should stand in front of the extended arm and hold it with his left hand, the thumb being fixed on the vein below the spot which is to be opened. With his right hand an oblique incision, not a puncture, should be made through the skin into the vein, describing with the lancet a semicircular movement. The bleeding-basin having been brought close to the arm, the surgeon's left thumb may be removed and the stream of blood allowed to flow. If this be feeble, the patient may be asked to grasp a stick and put the muscles of the fore-arm well into action.

The required amount of blood having been withdrawn, the tape can be removed, the left thumb of the operator being applied to the wound, and the parts cleansed. A pad of lint is then to be placed over the incision, the edges of which are to be kept well in contact, whilst the thumb is slipped downward to allow of the adjustment of the pad,

which is to be fixed by a figure-of-8 bandage (Fig. 185). The arm should then be slightly bent, care being taken that the pad does not slip during this process.

On the second or third day the pad may be removed, the wound having probably by that time healed.

Opening of the external jugular vein is sometimes called for, particularly when venesection is required in a child, and that part of the vein where it passes over the sterno-mastoid muscle should be selected. The vein can be steadied and rendered prominent by the left thumb of the surgeon applied at the root of the neck above the clavicle, or this may be done by means of a pad. It then is to be opened with the lancet by an incision made in the course of the sterno-mastoid muscle, and consequently across the platysma. Blood will then flow freely, and when enough has been taken, the wound should be closed by means of a pad carefully adjusted. The thumb, which hitherto has been acting as a compress, may then be removed. The pad should be fixed by good strapping.

In both these operations of venesection, if the wound in the skin be made smaller than that in the vein or the position of the arm be changed, a blood tumor or thrombus may form, from the escape of blood beneath the integument; and if this interferes with the flow of blood, instead of reintroducing the lancet, the best practice is to untie the arm and apply a pad to the wound, opening a vein in the other arm.

In fat subjects there is occasionally some difficulty in finding a vein. Friction of the surface of the fore-arm will at times help the surgeon, or the application of a hot flannel round the arm, which should be made to hang down by the side of the body. When these means fail and venesection is imperative, a vein of the foot may be opened.

In opening the jugular vein great care must be taken not to admit air into it by the removal of the thumb during the operation and until the pad has been adjusted; otherwise, life may be endangered.

Gross, Dr. S. W., *Amer. Journ. of Med. Science*, 1867 and 1871.—Callender, *Holmes's System of Surgery*, 3d ed., 1883.—Travers, *Surgical Essays*, 1818.—Langenbeck of Berlin, *Archiv für Klinische Chir.*, 1860.—Arnott, *Med.-Chir. Trans.*, vol. xv., 1829.—Lee, Henry, *Disease of Veins*, 1866.—Greene, James S., Dorchester, Mass., *American Journ. of Med. Science*, 1864.—Gay, *Varicose Diseases of Leg*, 1868.

THE SURGERY OF THE DIGESTIVE ORGANS.

CHAPTER XII.

AFFECTIONS OF THE LIPS, MOUTH, TONGUE, PALATE, AND TONSIL.

Wounds of the Lip.

Under all circumstances these wounds should be well cleansed from dirt, foreign bodies, and blood, and then carefully brought together by sutures, which should be deeply inserted and removed on the second or third day. Plaster, as a rule, is not required. Superficial wounds in the inside from the teeth may be left to granulate. When much bleeding exists the surgeon should examine the part with care, as Erichsen adduces a case in which from the coronary artery so much blood was lost, swallowed, and brought up again by vomiting as to lead to the suspicion of some internal injury.

Fig. 186.

Congenital Fissure of Lower Lip and Jaw, with Tongue in Fissure. (Dr. Thorndike's case.)

Congenital Fissures of the Lips.

These occur more frequently as harelip than in any other form. Sir W. Fergusson has, however, quoted three cases in his *Practical Surgery* in which the fissure extended from the angle of the mouth—in one case to the malar bone, in the second toward the angle of the jaw, and in the third to the base of the lower jaw; and from a case reported in the *Med. and Surg. Reports* of the City Hospital of the city of Boston, United States, 1882, it seems that the lower jaw and soft parts over it may be fissured in the median line (Fig. 186). In the case recorded, when the patient, æt. 20, opened her mouth, the two halves of the lower jaw protruded laterally like horns and presented a large cavity, and the tip of the tongue was bound down to the tissues in front of the hyoid bone. Dr. Thorndike, who reports the case, closed the fissure by first dissecting up the tongue from its adhesions and uniting the bones and soft part by a plastic operation.

Harelip.

This congenital deformity is due to a want of union between the natural centres of development of the upper lip. Thus, the upper lip is made up of a central and two lateral portions, the central being connected with the intermaxillary bones and the lateral with the superior maxillary (Fig. 187). A want of union between the central and lateral piece on one side gives rise to simple harelip; a want of union between the central and lateral pieces to double harelip.

Fig. 187.

Showing the Development of the Intermaxillary and Maxillary Bones. (From Fergusson.)

Fig. 188.

Central Fissure of Lip with Deficiency of Intermaxillary Bones. (Mr Howse's case.)

When the fissure is central—a very rare condition—the intermaxillary bones are either absent or divided. A specimen of the former exists in the Museum of the Royal College of Surgeons, London, and a drawing of a like case taken from a patient of my colleague, Mr. Howse, is seen in Fig. 188. These fissures may be partial or

complete, and may involve the skin alone, as also the bone, and the latter in variable degrees.

Congenital cicatrices are occasionally met with in the upper lip (*vide* Fig. 52) along the line of union of the central with one or other lateral portion. Fig. 189 was taken from a patient with this imperfection, and in her case there was a slight elevation of the

Fig. 189.

Congenital Cicatrix.

Fig. 190.

Harelip as Slight Notch.

Fig. 191.

As Deep Fissure on Right Side.

mucous margin of the prolabium, which may be said to be the very earliest indication of a harelip; the child of this woman had a complete fissure. In more complicated cases the cleft will extend through the alveolar process in a line corresponding with the labial fissure, Fig. 191; in others it will involve the hard palate; while in a still worse class both hard and soft palate will be fissured.

In a small percentage of the cases—about a tenth—the harelip is double. In these it is not uncommon to find a double fissure extending through the palate, the two superior maxillæ with the skin having failed to unite with the intermaxillary bones. Under these circumstances the intermaxillary bones will often project, covered with a small flap of skin, and at times even stand out from the tip of the nose. In a rare case (illustrated in Fig. 193) the fissure involved the lip and intermaxillary bones alone, the maxillæ being complete.

Fig. 192.

Uncomplicated Double Harelip.

Fig. 193.

Complicated with Fissure of Alveolus and Projection of Intermaxillary Bone, the Palate being Perfect.

This affection is more frequent on the left than on the right side of the mouth, and is more common in males than in females, while in the more complicated examples this disproportion becomes more striking. Thus, in an analysis of cases to be found in my *Lettsomian Lectures on the Surgical Diseases of Children*, 1863, four-fifths of the bad cases were in boys, those of double harelip almost always being found in the male sex.

Treatment.—When ought a child with harelip to be operated upon? Sir W. Fergusson says, "I am of opinion that the earlier the operation is performed, the better—assuredly before teething:" and the majority of surgeons would support this opinion. Judging from my own experience, I am not disposed to coincide altogether with this view; for in my analysis of cases at Guy's Hospital a larger number of failures followed the operation when performed during the first few weeks of life than after the third month. In healthy infants it is probable that success may attend the operation whenever undertaken, but in the more feeble it is equally probable that success will be more certain at a later than at a very early period. Under these circumstances, I always advise the operation to be postponed until after the third month—that is, when no necessity exists to hurry on the operation, such as inability to take food, etc. On account of this last-named condition, I have operated with complete success on the fifth day.

The position of the patient is important. If an infant, the whole body and arms should be bound round with a good towel and the head fixed by the hands of an assistant, placed on either side. The child should be firmly held in a nurse' lap, in the sitting posture (Fig. 194). In other cases the child's head may be laid on the surgeon's knees, the body on the nurse's.

If an older child, the semi-recumbent position should be chosen, with the head raised on a pillow and fixed as directed above.

The operator may sit or stand behind the patient when the recumbent position is selected, or at one side if the patient be sitting.

Operation.—Anæsthetics may be given without fear in such cases, although in uncomplicated examples the operation is so expeditiously performed as not to render it essential.

The surgeon has in the operation two main objects in view—viz., to pare the edges of

the fissure, and to adapt them so as to render the deformity as slight as possible. But before this an important preliminary step demands attention, and on it the success of the case materially rests: it is to freely separate both sides of the lip from the alveoli, and when the nostril is widely expanded to freely separate also the ala nasi from the bone. The object of this step is to allow the soft parts to move freely over the bones and to be brought the more readily into apposition. Some save the true frænum and divide all other adhesions, but I see no necessity for this practice. To pare the edges of the cleft the knife should be employed, such an instrument making a cleaner section than scissors; and this cleanness of the incision is a point of importance. With respect to the form of incision, numbers have been devised, but most surgeons fall back upon the old-fashioned straight one above the prolabium, commencing at the apex of the cleft and ending at its free border, care being taken to cut off a good piece. The plan I always follow when the knife reaches the red border of the lip is to turn its edge obliquely toward the cleft, thereby saving a portion of the mucous covering of the lip and lessening materially the notch in it (Fig. 195). The incision having been made and all bleeding vessels twisted, the surgeon should proceed to adjust the parts; and he had better commence at the free margin. When pins are used, they should be fine, with flat heads, and one should be introduced about a third of an inch from the margin of the wound and brought out just under the mucous lining of the lip, reintroduced on the opposite side, and passed through the lip. The edges can then be brought together by means of a twisted well-oiled suture, care being taken to adapt accurately the parts at the red margin of the lip. If this end be attained, the second and third pins should be inserted above, one close to the nostril, the second between the two, and both fastened separately. If the interrupted silk, gut, or horsehair suture be employed instead of pins—a practice I greatly prefer, having given up pins in simple cases—it is wise to introduce a needle as the first pin to adjust the parts, and then insert the second and third stitches, putting in afterward the marginal suture by simply drawing the needle that had been introduced as a pin through the flaps. In most cases it is serviceable to insert a fourth suture into the red border of the lip itself. The button suture (Fig. 8) may be used instead of the above, if preferred.

Fig. 194.

Fig. 195.

Operation for Single Harelip.

After the operation Hainsby's truss should be employed when possible (Fig. 196). It keeps the parts well together and prevents any traction upon the wound. It is a valuable instrument. When it cannot be obtained, the cheeks should be well drawn forward and held by some good plaster, applied either from ear to ear or from the temple on one side beneath the chin to the temple on the other. The sutures or pins may generally be removed about the second or third day at the latest, and after their removal the cheeks must be held forward by strapping.

Fig. 196.

Hainsby's Truss.

Mr. Maurice Collis in 1866 (*Dub. Quart.*), in an able paper on harelip, among other points laid great stress upon the propriety of utilizing the parings. He never threw away a particle of them, but used them all. I have followed his suggestions—in many cases with admirable success—and am disposed to think that where the lips are thin his method is of service. His operation is as follows: He first made an incision from A to B (Fig. 197) through the thickness of the lip down to the mucous membrane, but not through it, and turned the flap back. On the other side he transfixed the lip at C and separated the flap as far as D, dividing the flap in the centre at E. He then brought the two sides together by fixing the upper flap, C E, by a suture to A, and the lower flap, E D, to B. "Two intermediate sutures being applied (Fig. 198), I thus obtain," says Collis, "a lip nearly double in depth what I could possibly have got by the ordinary incisions."

Malgaigne's operation is, in a measure, somewhat similar to the above, utilizing as it does the flaps of skin by turning them down and stitching them together (Fig. 199). In some cases one of the pared edges may be left attached and united with the opposite side that has been sloped to receive it. This suggestion I had from Mr. Dix of Hull in 1859 (*Med. Times and Gaz.*, July 2).

Double Harelip.—When this is uncomplicated with bone displacement, it can be

dealt with as simple harelip. In a general way, it is well to operate on both sides at once, more particularly if the lower flaps of the lateral portions are utilized by being turned down and united beneath the central piece (Fig. 201). If there be, however, much

Fig. 197. Fig. 198. Fig. 199. Fig. 200. Fig. 201.

Collis's Operation for Harelip. Malgaigne's Operation. (From Holmes.) Operation for Double Harelip.

separation, and, consequently, traction upon the lateral portions, the operations upon the two sides should be performed separately.

When the intermaxillary bones project to any extent and are separated from the maxillary, there will be some difficulty in the treatment. I believe the better plan is to remove them with the knife or scissors; for when broken and bent back, the central incisor teeth too often grow in some abnormal position and are in the way. When removed, the maxillary bones subsequently approximate, and the lateral incisor teeth frequently assume the position of the central. Sir W. Fergusson latterly removed these bones, or the milk tooth with its bony bed, subcutaneously, and, I think, with advantage. When they are so pushed forward as to form a kind of appendage to the tip of the nose, as seen in Fig. 202, they ought to be removed. The portion of skin over the bones, however, must always be utilized, either to form a columna nasi where none existed, as in Figs. 203 and 204, or to be brought down and inserted between the two lateral portions of the lip.

Fig. 204. Fig. 203. Fig. 202.

Side View. (After operation.) Front View. Before Operation.

When primary union fails, the surgeon can often succeed in securing union by the third intention by scraping the surface of the wound and reapplying the sutures; and he may do this, although the parts have sloughed at first, as soon as healthy granulations appear.

Cheiloplastic Operations.

These are demanded for deformity of the mouth from destructive ulceration or sloughing, as from cancrum oris, and are somewhat similar to those for harelip. When undertaken for contraction of the mouth, the surgeon should always try and turn up some portion of the mucous membrane from within the mouth, to cover over the new angle and thus prevent its subsequent contraction. I have done this in several cases with gratifying success, one of which is figured Fig. 205. The deformity was the result of sloughing after fever. At times new tissue must be brought up from the chin or down from the cheek. Indeed, these cases tax the ingenuity of the surgeon to the utmost, since no general rules can be laid down regarding them, each requiring to be dealt with on its own merits. But this much may be said—that no part of the body heals so rapidly or so well as the face, and in none are plastic operations more satisfactory.

Fig. 205. Fig. 206. Fig. 207.

Deformity Result of Sloughing. After First Operation. After Second.

Cancer of the Lips.

This term is generally applied to epithelioma or cancroid disease, true cancer or carcinoma being very rare. It is a disease of middle life, four out of five cases attacking patients between forty and sixty years of age. The youngest subject I have seen affected by it was a sweep æt. 27, and the oldest also a sweep æt. 86. It affects the lower lip more frequently than the upper in the proportion of 25 to 1. In my own table of 54 consecutive cases, 3 instances were found in women to 51 in men.

Smoking, or rather the irritation of a pipe, has generally been ascribed as a common cause; and it is probable that such an irritation is sufficient to set up the disease when a predisposition to its development already exists. It is interesting to note, however, that 9 out of 54 consecutive cases in which I made the inquiry had never smoked; and this proportion is probably about that of the non-smokers amongst the male population in this country.

The disease generally commences as a dry scab on the red margin of the lip, and it may be that this scab forms over a crack or excoriation, but as often as not it appears alone; occasionally, too, it commences as a wart. In its early stage the progress of the disease is generally very slow, and only when some ulcerative action appears does it develop more rapidly. It is under these circumstances that the patient first applies for advice; the disease in the dry state is passed by unheeded.

Fig. 208.

Extreme Example of Cancer of Lip.

The appearance of an epithelial cancer is tolerably characteristic (Fig. 208); it has generally an irregular warty aspect, but when ulcerating has thickened everted edges. It has always a well-defined indurated base. When ulcerating, it discharges a sanious pus containing epithelial scales in abundance; and when dry, it is covered with a scab of the same material. Microscopically, it contains epithelial elements arranged in capsules. (*Vide* Fig. 45.)

In its early stage it should be regarded as a local disease. It rarely affects more than one part at the same time, but I have seen several cases in which two separate centres existed, and one in which there were three. In the latter, two growths on the lower lips were excised, and nine years subsequently a similar disease attacked the tongue, which I removed in June, 1870.

When the ulceration stage has set in and the disease has been left to run its course, the glands beneath the jaw will probably become affected, and the affection will steadily, if not rapidly, progress until all the tissues with which it comes in contact—integument, gums, bone, teeth, and glands—are destroyed. It destroys life by exhaustion and hemorrhage, and may do so by secondary deposits in the lungs or viscera, but far less frequently than does carcinoma. In a case under the care of Mr. Howse, in 1875, the disease spread from the lip to the lower jaw and along the course of the fifth nerve to the base of the skull and brain, destroying life by meningitis.

Treatment.—There is but one treatment that can be recommended, and that is the speedy removal of the disease. When once the nature of the case is clear, the sooner the growth is taken away the better; and in doing this the surgeon must deal freely with the surrounding parts. He had better err by removing too much than too little of the surrounding tissues. To tease the parts with mild caustics is bad practice, as it merely irritates, and rarely destroys, the whole growth. Caustics cannot as a rule, be recommended. Excision is probably the best method. When the disease is superficial, it may be sliced off, leaving the parts to granulate; when it involves more of the lip, a V-shaped piece may be taken out, the two edges being brought together as in harelip. When much of the lip is affected, the whole must be removed and a new lip formed by bringing up the soft parts from the chin as indicated in Figs. 209, 210.

Fig. 209.

Diagram showing the Lines of Incision for New Lip after Removal of a Cancer.

Fig. 210.

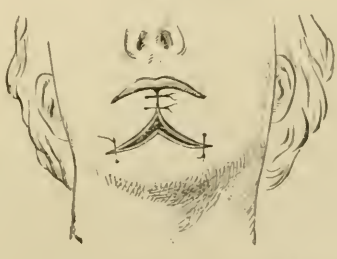


Diagram showing Position of Flaps when brought Up.

Recurrence of Disease.—After the removal of the disease a cure may follow, but in the majority of cases a return takes place, and generally in the same spot. Similar treatment must again be resorted to, even to a second and third operation, as there seems

reason to believe that after each operation a longer interval of immunity may be promised. Thus, a man who had a cancer of the lip removed a year after its appearance was well for two years, when a second operation was required. He remained well for three years, when a third was performed and this time four years elapsed before a return took place. It was then excised for a fourth time.

In another case a man æt. 65 had a cancer of his lip removed fifteen years before he came under my care. He remained well for eight, when, the disease returning, a second operation was demanded; and seven years after this he was well. Epithelioma of the lip is of slow growth. I have removed one from a man æt. 74 of twenty years', and another from a man æt. 50 of eight years'. growth.

Horny growths may spring from the lip, as from other parts of the cutaneous surface (Prep. 1678⁵, Guy's Hosp. Mus.).

Chancres, syphilitic or otherwise, are at times met with on the lips, and the surgeon should be on his guard not to mistake them for cancer. They mostly appear as raised smooth sores with bases of cartilaginous hardness, and are usually attended with considerable inflammatory swelling as well as with secondary glandular enlargement. They have neither the clinical history nor aspect of such an affection as cancer, but make much more rapid progress, and are, moreover, usually met with in younger subjects. When syphilitic, the constitutional symptoms—commonly called "secondaries"—will mark their true nature.

Hypertrophy of the Mucous Glands of the Lip.

The mucous covering of the lip is often found to be thickened, two elevated or pendulous portions of tissue appearing, one on either side of the middle line. This condition authors have described as *hypertrophy*, though the name does not appear to be

Fig. 211.

Hypertrophy of Mucous Glands of Lip.

Fig. 212.

Hypertrophy of Lip. (Mr. Davies-Colley's case.)

always correct, for on removing the so-called hypertrophied mucous membrane in many cases a number of small granular bodies the size of hemp-seeds, and made up of gland cells, are to be found underlying a healthy mucous membrane. The disease appears, therefore, to be often due to an increase in the size of the natural glands, and not of the mucous membrane of the part (Fig. 211). It should be treated only by the careful excision of the diseased submucous tissue, the incision being made in the line of the lip and the edges brought together by fine sutures. I have seen as many of such cases in the upper as in the lower lip, and rarely does it involve both lips. I have never known it to recur.

A genuine hypertrophy of the lip itself is a common affection. It often begins as a chronic inflammation, or rather œdema, of the part, the inflammatory deposit becoming organized. There can be little doubt that many of the so-called thick strumous lips have this origin. Attention to the general health and its improvement is the means by which cure may be expected. In some instances the hypertrophy is very marked. Thus, in a case recorded by Mr. Davies-Colley,[1] and illustrated in Fig. 212, nothing less than an excision of a V-piece from its centre was of any use.

Cystic Tumors of the Lip.

Mucous cysts are often seen, and generally in the lower lip. They appear as tense, globular, and at times semi-translucent, tumors beneath the mucous membrane,

[1] *Clin. Soc. Trans.*, vol. xvi.

and are readily cured by excision or by cutting off their upper wall by means of scissors and sharp-pointed forceps. An incision into them rarely does good. They contain a glairy mucoid fluid.

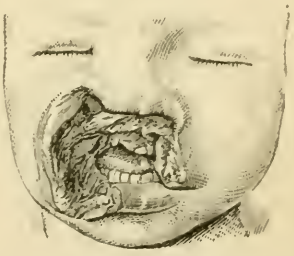
Glandular Tumors.—On several occasions I have turned out of the lip, from beneath the mucous membrane, solid encysted tumors with a glandular structure.

Nævi of the lip are often seen; and when they involve the whole thickness of the part, their removal by a V-incision is the best treatment. I have done this on many occasions with a beneficial result. When they are only superficial or beneath the mucous lining, they may be treated locally, as already mentioned in the chapter on nævus.

Phlegmonous or carbuncular inflammation of the lip is an alarming affection; it is never found except in the feeble and cachectic. It attacks the upper as well as the lower lip, and shows itself as a general infiltration of the part, which becomes enormously swollen, tense, and painful. When seen in an early stage, a free incision into it or its mucous surface gives relief and expedites the sloughing of the cellular tissue that is sure to follow. Fomentations and warm-water dressings are the most beneficial, with good living and tonics, such as quinine and iron in full doses. At times this affection ends in sloughing, and then puts on the appearace of what is called "cancrum oris." It is very prone to be followed by septicæmia.

Cancrum oris, or gangrenous stomatitis, is generally met with in the ill-fed and feeble child after one of the exanthemata. It is seen also where mercury has been given to salivation. It commences often as a phlegmonous inflammation of the cellular tissue of the cheek or lip, going on rapidly to sloughing and phagedænic ulceration, or to sudden death of a part of the cheek, the tissue becoming white and bloodless and then sloughing. At times this sloughing process will involve a large portion of the cheek, and even of the gum or the bone. It is a most fatal and dangerous disease. Before the sloughing has taken place the part involved will be much thickened and indurated. It will feel of a brawny hardness and appear of a dusky color in the centre, with a red border. When the skin covering in the dead cellular tissue has sloughed away, a deep, excavated, irregular surface will be seen discharging an offensive sanious fluid; and if the disease spreads, it does so by sloughing and ulceration (Fig. 213). It generally kills by exhaustion, sometimes by bleeding from the sloughing of an artery.

FIG. 213.



Cancrum Oris.
(Model 26⁵, Guy's Hosp. Museum.)

TREATMENT.—The general treatment consists of tonics and good feeding, milk, eggs, and wine, beef tea, and any other nutritious food being of primary importance. When food cannot be taken by the mouth, it must be given by the bowel as enemata. Tonics also must be administered, as the liquor cinchonæ, quinine, or iron, in such doses as the child can bear.

Locally, till the slough has separated, little more than fomentations and cleanliness can be employed: but when the sloughing and ulceration spread, the application of strong nitric acid or tincture of iodine is of great value. It must, however, be liberally brushed over and into the parts, so as to destroy all their surface and induce a fresh action.

Absolute cleanliness should be observed, the wound being washed and irrigated by means of a steady stream of water to which carbolic acid one part to twenty, Condy's fluid, chloride of zinc, or iodine tincture in the proportion of ɱxx to the ounce of water may be added. When recovery takes place, it is frequently with the loss of large portions of the affected parts, for which some plastic operation will subsequently be required.

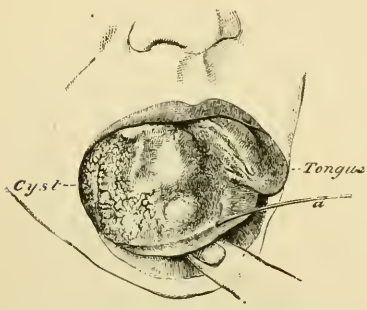
Aphthous stomatitis is another affection often mistaken for cancrum oris, but is not, however, half so dangerous. It occurs, likewise, in the unhealthy and ill-fed child, but as often as not is independent of the exanthemata. It begins as an aphthous ulceration of the tongue, gums, lips, or cheeks, by which these parts become covered with a white or ash-colored secretion. With these local symptoms there will be a foul tongue and fetid breath, as well as some evident symptoms of derangement of the bowels and digestive organs. In very feeble children this superficial ulceration may pass on to sloughing of the parts, or *ulcerative stomatitis*, thus simulating *cancrum oris*, but with this difference: in *cancrum oris* the disease begins in the cellular tissue, the skin sloughing subsequently; in *ulcerative stomatitis* or *noma* it begins as a skin or mucous membrane ulceration, sloughing following upon it.

Treatment.—Of all drugs, the chlorate of potash has the best action, and should be administered in five-, or even ten-, grain doses mixed with bark or with milk, a lotion of the same drug, ʒj to a pint of water, being used as an application. Milk diet is the best where it can be taken, beef tea and eggs being given otherwise or in addition. Wine must be administered with great caution, and only when the powers of the child are very feeble, as in the phagedænic form. A rhubarb purge is usually required at the beginning of the affection, to clear the way, as foul excreta are too often present, and in the later stage the more powerful tonics, such as iron or quinine, are often demanded. At times small doses of laudanum, say one or two drops every few hours, relieve pain and allow the child to feed with comfort, and consequently with benefit. This affection is a disease generally due to intestinal irritation from bad feeding, and requires, therefore, for its treatment careful attention to this matter.

Ranula or Sublingual Cysts.

These are now known *not to be* due to any obstruction of the salivary ducts, submaxillary or sublingual, but to obstruction of one of the mucous glands situated beneath the tongue, such as the glands and ducts of Rivini. They are probably analogous to the mucous cysts of the lip already alluded to, and of the mucous passages generally. They contain a clear, glairy, mucoid fluid, but never saliva. I have the notes of several that were *congenital*. They sometimes attain a large size; and when placed beneath the tongue (their usual position), the salivary duct can readily be traced lying over them (Fig. 214). Sometimes they are multiple, and on several occasions, on opening one cyst, I have seen a second within. When neglected and allowed to increase, they may so press the tongue upward as to prevent the patient speaking, or they may form a large swelling beneath the jaw. Within the mouth they appear as semi-transparent cysts beneath the tongue, and they are, as a rule, painless and merely give trouble mechanically. When opened, a glairy mucoid fluid escapes. This operation, however, rarely is serviceable, as the fluid re-collects.

Fig. 214.



Ranula or Sublingual Cyst, with Salivary Duct lying upon it. (Guy's Hosp. Mus., No. 2293[36]. Hilton's case.)

Treatment.—The best treatment is to raise the upper wall of the cyst by means of a pair of pointed forceps or a tenaculum, and with scissors to cut it off. M. Panas of Paris has lately injected these cysts with three to ten drops of a solution of chloride of zinc (forty-five grains to an ounce of distilled water) with success. In large tumors the cavity may be plugged with lint soaked in iodine after it has been freely incised. The application of a seton is at times beneficial, though an uncertain remedy; simple plugging of the cyst was a mode of treatment that I formerly employed till I discovered that the plans above suggested were preferable. It is rarely possible to excise the cysts, as they have no definite walls. I have, however, seen this practice carried out with success.

Encysted tumors are, however, met with beneath the tongue. I have had two under care, and both I mistook for ranula. The error was discovered only on opening them, and in both, on making my incision, I had to cut through the mucous lining of the mouth over the cyst, and then the cyst wall itself. From both a cheesy sebaceous secretion escaped.

These tumors—which have nothing to do with ranula—have distinct capsules beneath the mucous membrane and appear to be sebaceous; they are probably congenital. In the cases I have mentioned the patients were under twenty years of age. In both I pulled out as much of the cyst wall as I could, dissecting it from its bed, and in one with complete success. In the second a return followed, which called for another operation, which was crowned by a good result. I have never known any of these cysts require removal from below the jaw. In one of my cases I contemplated this plan, and Sir W. Fergusson and Mr. A. Barker give cases where it was adopted. It is probable, however, that incising and plugging the cyst, to set up suppuration, after evacuating its contents, would be a simpler and equally efficacious practice.

Salivary Calculus.

The salivary ducts beneath the tongue may be obstructed in exceptional cases from the introduction of foreign bodies, but more commonly from *calculus*. Steno's or the duct of the parotid may be thus affected, but the Whartonian or the sublingual salivary duct is that more commonly involved. When the obstruction is complete, patients complain during deglutition of pain and swelling in the corresponding salivary gland; such symptoms, which are clearly due to retained salivary secretion, soon subside on the completion of mastication. In exceptional examples suppuration may attack the gland.

Fig. 215.

Nat. size

Salivary Calculus.

The calculus depicted in Fig. 215 was taken from the sublingual duct of a man by my friend Mr. C. Sells of Guildford, and weighed forty-eight grains.

This affection can usually be easily recognized on the application of the finger beneath the tongue, the calculus, as a rule, holding a superficial position. On feeling the stone the surgeon may often with his nail tear it out of its bed. I have removed several by this plan when not larger than hempseeds. When larger, the best plan is incision, the surgeon being careful to cut through the duct where it seems to be thinnest and scoop the calculus out of its bed by means of a director or bent probe. These calculi may attain considerable dimensions, even one inch long. On one occasion I broke a calculus to pieces in attempting to remove it from the centre of a suppurating sublingual gland of a man æt. 42 who had had evidence of its presence for years. He came to me with the parts hard as well as ulcerating, having been told he had a cancer, but a rapid recovery followed its removal. Occasionally after the removal of a calculus from a salivary duct a stricture results, and then the gland, under stimulus, may inflame and be the source of trouble. I have seen several cases demonstrating this fact. A free division of the duct is then the right treatment to adopt.

Salivary Fistula.

When Steno's duct, the duct of the parotid gland, has been obstructed near its orifice in the mouth or has been opened by a wound or ulceration, a salivary fistula may take place—that is, the saliva, instead of being poured into the mouth, will escape upon the cheek. When this affection originates in some obstruction to the duct itself, it will commence as a soft fluctuating swelling in the cheek, caused by retained salivary secretion; and after a time, usually when the duct has acquired about the size of half a walnut, the swelling will ulcerate through the skin and clear saliva or saliva mixed with pus will escape. If this swelling be opened, the same result will ensue; and after this the cavity may contract, but the fistula will remain.

Treatment.—The only successful treatment of this affection is to establish a free opening into the mouth from the oral end of the duct, which may be effected by passing a fine probe into the fistula through the duct into the mouth. When this can be accomplished through the natural opening, all the better; but it is not a matter of much importance, as an artificial opening near the oral orifice of the duct will answer every purpose. The probe should be armed with a piece of thick silk or three or four threads of fine silk and drawn through the mouth, the ends hanging from the cheek and those from the mouth being tied together, the whole acting as a seton to establish an artificial fistulous communication with the mouth. This object will probably be secured in about a week or ten days, when the seton may be removed. The fistula in the cheek will then probably contract and close of itself; but if this does not take place, the edges of the fistula may be cauterized by the galvanic or benzoline cautery, and thus cicatrization be encouraged. The operation may be repeated if required. A plastic operation may be attempted when these means fail.

Cervical Salivary Fistula.—I have known *parotid* salivary fistula follow upon the suppuration of the gland after fever in three cases, the orifice in all being small and placed behind the angle of the jaw. In none of these was there any obstruction to Steno's duct. It was troublesome only from the trickling of saliva during mastication, though to one of the patients, who was a lady, this caused much annoyance. I tried the cautery in one of these cases, but without success.

Parotiditis, or "Mumps."

This is a simple although an infectious disease, having a tendency to get well with simple fomentations of the parts, a saline purgative, and a mild tonic. It generally attacks the young, but I have met with it in a lady æt. 82. Its incubation period may extend over three weeks. It is frequently metastatic to the testicle. When it follows upon a fever, it is a severe affection, and not unfrequently passes on to suppuration. Such abscesses spread easily, the deep fascia covering them in forbidding a natural outlet except by burrowing. As a complication of pyæmia it is very serious. Salivary fistula in the neck may follow in such cases. Professor Crocq of Brussels believes this disease is the result of a stomatitis propagated along the duct of the parotid gland to the gland itself.

Parotid Submaxillary Tumors.

These have one peculiarity—viz., that they are almost always more or less cartilaginous, the ordinary form of tumor in this region being the fibro-cartilaginous; they are, moreover, mostly encysted, having a peculiar hard, elastic feel and botryoidal outline. They are generally imbedded in the structure of the gland and vary much in their depth, tumors that appear movable and superficial too often dipping deeply down into the tissues, and thus increasing the difficulty of their removal. These simple tumors may grow to a large size and stretch the skin greatly over them; they should always be removed—the earlier, the better. In removing them the surgeon should be careful to make his incision well down to the capsule, when he will probably be able to enucleate the growth. It is far better practice to do this, even with the application of a little force, than to be too free with the knife; for the facial nerve is generally in close contact with the tumor and the deep vessels are beneath. He should also always cut upon the tumor, dividing only such tissues as hold it down, taking great care too that the large vessels are, if possible, left uninjured. In deeply-placed tumors this removal by enucleation is still more necessary. When the tumor is large, there is always a strong probability that the facial nerve will be divided or injured; hence it is as well to prepare the patient for the fact. Fig. 216 illustrates the situation and external appearance of one of these tumors.

Fig. 216.

Submaxillary Tumor.

Cancerous tumors of the parotid are likewise met with, but assume a very different appearance from the last. They are mostly infiltrations of the gland, fixed, diffused, and deep-seated; they are, moreover, generally associated with paralysis of the facial nerve, differing in this way from innocent growths. In such cases surgical interference is rarely beneficial.

The difficulty of deciding as to the removal of large growths in this position is very great, and the best guide is their mobility. Sir W. Fergusson, who had more experience in these cases than any man of modern times, says, "If it were evident that the part slid freely over the subjacent textures, I should not hesitate about using the knife, whatever might be the bulk of the disease," etc.; "but if the tumor seemed fixed, its limits were not clearly defined, or an attempt to move it caused pain, I should not readily be induced to use the knife, however small the mass might be;" and I endorse these views.

AFFECTIONS OF THE TONGUE.

Tongue-tie is occasionally met with, but not a tithe of the cases so ascribed are of this nature. It is due to a tying down of the tip of the tongue by the frænum linguæ, which prevents the infant from projecting the organ beyond the gums, thereby interfering with suckling.

Treatment.—It is easily remedied by dividing the frænum perpendicularly downward behind the gum with a pair of blunt-pointed scissors, the point of the tongue being elevated with the finger or a pair of dressing forceps applied beneath.

Ankyloglossis.—Under this heading cases of fixed tongue are grouped. In some the organ is wholly adherent to the floor of the mouth; in others, by bands. Under the

latter circumstances freedom may be given by the division of the bands, but under the former little hope can be expected by treatment, although an attempt to raise the organ would be justifiable.

Wounds of the Tongue.

These are sometimes troublesome from hemorrhage, but when the parts are brought together the bleeding, as a rule, ceases; all bleeding vessels, however, ought to be tied or twisted. I have known death to follow a small wound in a child from the trickling of blood down the pharynx as well as the larynx, the child dying in the latter case asphyxiated; and all surgeons recognize the danger of slow bleeding after a tongue operation. Sutures should always be employed when gaping exists, and these must be put in deeply, to draw the whole thickness of the divided parts together. On one occasion, owing to a neglect of this practice, I had to pare the surface of an old wound that had passed through the half of the tongue transversely, and then bring the parts together. The child was unable to talk clearly, on account of the injury; yet after the operation all was well.

Dentists' Wounds.—Since the introduction of nitrous-oxide gas for dental operations, the element of hurry has had the effect of causing many wounds of the tongue of the contused kind. They are the result of the forceps of the dentist seizing the tongue, with or without a tooth, in a hasty extraction. On several occasions I have found it necessary to cut off the contused and lacerated flap of tongue. When bleeding is obstinate and the parts cannot be brought together, the cautery or perchloride of iron may be usefully employed. In exceptional cases the ranine artery may require a ligature. Ice in the mouth arrests slight hemorrhage.

Congenital Affections.

Hypertrophy, or macro-glossia, is, without doubt, a congenital affection, although in certain reported cases it may not have been observed till the first or second year of life. It is usually an affection of slow growth and troublesome on account of the mechanical obstruction it causes to deglutition and speech; when the disease has existed for years, it produces deformity of the teeth and jaws, from the local pressure of the tongue upon the former and the non-closure of the mouth. Syme published a case in which the tongue projected for three inches out of the mouth of a girl aged 14; and Humphry another, in a child aged 11, in which, when the tongue was withdrawn into the mouth as far as possible, the exposed part measured, from the upper lip to its tip, two inches. Many other cases are also on record. As a rule this affection involves both sides of the tongue, but in exceptional cases it may affect but one. The growth is generally painless, and the disease not rarely affects idiots and children with ill-formed crania. A case in which the disease was congenital and confined to the right half of the organ occurred in a boy who, when six years of age, was admitted into Guy's Hospital, under the care of the late Dr. Thomas Addison, with his tongue protruding far out of his mouth and obstructing respiration. His mother stated that the tongue had been affected ever since his birth, and that he had never been able to articulate distinctly. Whenever he took cold, the tongue became swollen and blisters formed upon it, which burst and bled. The increase of the disease had been gradual. He was treated with mercurials, and he derived so much benefit from them that he left the hospital with the tongue fairly retracted. He reappeared, however, three years later (1856) with the same disease, the growth having rapidly increased for one month before his admission; he then came into the hands of the late Mr. John Hilton. At that time the right half of the tongue, with the submaxillary glands, was much enlarged; the whole organ was protruding from the mouth and the papillæ on the affected side of the tongue were much hypertrophied. He was again treated with half-drachm doses of the solution of the perchloride of mercury, and left relieved. In another three years the tongue had grown as large as ever, and he was readmitted for the third time, when the tongue presented much the same appearance as it had on his previous admission, although the papillæ seemed coarser. He was treated in the same way as on the two previous occasions, and he left relieved. No further history of his case is known.

It should be mentioned that in this case there were no symptoms of the presence of nævoid tissue. The tongue appeared coarse, thickened, and enlarged, as if from simple muscular hypertrophy, and yet, from the fact that the enlargement diminished under the influence of mercury, there must be a question as to this being its true nature. Indeed,

the case appears pathologically to be like one shown at the Pathological Society in 1872 by Mr. H. Arnott, in which, after its removal, there was visible microscopically very little true muscular hypertrophy of the organ, but the epithelial covering of the tongue was very thick and the papillæ were enlarged; the blood vessels were larger than usual, and there were large irregular spaces with thin walls, which were filled with blood or clear fluid; a few vesicular bodies, which may have been enlarged lymphatics, were also present. Macro-glossia, as a disease, is, according to Mr. Arnott, probably due to a variety of causes —that is, to (1) a true muscular hypertrophy of the organ; (2) a nævoid affection of its blood vessels; (3) a thickening and induration caused by a long-continued subinflammatory state; or (4) a general enlargement of the lymphatics of the tongue.

TREATMENT.—The treatment of this affection has hitherto been excision either of a wedge of tongue, as successfully performed by Humphry, or the removal of the projecting portion of the organ by the knife or écraseur. Good, also, has said to have been derived from ignipuncture. But mercurial treatment should certainly be employed in some cases before recourse is had to surgical interference, since in the case I have recorded the benefit of the drug was most striking.

In some cases of enlargement, and more particularly when the disease is not congenital, but acquired, and consequently probably inflammatory, the effect of the iodides should also be tried. In the following case of a gentleman æt. 20 who consulted me some years ago for enlargement of the tongue of twelve years' standing, and which I from its history regarded as inflammatory, the drug proved valuable. The enlargement was associated with a protrusion of the organ and all the consequent evils. Iodism, induced by ten-grain doses of the iodide of potassium three times a day, was followed by the speedy disappearance of the affection, though at the time death appeared imminent from the excessive swelling of the organ caused by the drug.

I should like to mention that so early as 1807, Sir A. Cooper removed a portion of a tongue weighing on removal 2 ounces 2½ drachms (Troy) and measuring 3½ inches in length, 3 inches in breadth, and 1½ inches in thickness, from a man æt. 53 who had been troubled with the enlargement for six months. The disease was supposed to have been brought about by the use of mercury given for syphilis. The case did well.

On Growing and Degenerating Nævi of the Tongue.

These cases are not very common, and out of about half a dozen that I have seen the following is the best. I first saw the case when the girl was an infant, and the tongue presented the appearance and feel of a vascular sponge. The whole organ at that time was swollen, and large distended veins coursed over and under its surface, more particularly on its right side; it had likewise a very full arterial supply. On the application of pressure by means of the thumb and fingers the tongue was readily emptied of its blood, and on its removal it at once refilled. The case was brought to me for treatment. I advised that nothing should be done, and I did so on the recognition of the fact that nævi have a tendency to undergo degenerative changes, and in the hope that these changes would take place in the tongue. In this hope I was not disappointed, for during the twelve years that passed since I first saw the case many changes took place in the part, and the most typical was the cystic degeneration of the nævus. These changes began when the child was about six years of age and have steadily continued. At present the tongue has quite lost its spongy feel. In consistence it is tolerably firm, but it feels harder in some spots than in others. To the eye its surface looks to be made up of vesicular warts, these vesicles being filled either with clear or more or less blood-stained serum. In fact, the tongue appears precisely as any nævus appears which has undergone the peculiar cystic warty degeneration to which such growths are prone. It has, however, probably less of the papillary hypertrophic growths on its dorsum than many nævi on mucous surfaces show. These appearances are confined to the upper surface of the tongue, for its lower aspect still presents, in a degree, the venous engorgement which originally characterized the whole growth.

The appearances I have described are absolutely typical of a degenerating nævus, since no other growths ever undergo like changes or present any like features.

I must mention here a curious *complication* which presented itself in this case, and which is difficult to explain, though I am disposed to think it had something to do with obstruction of the lymphatics. It appeared when the child was ten years of age and when the cystic degeneration of the nævus had far advanced; it showed itself as a painless swelling of the neck, which began in the right submaxillary region and descended

backward toward the angle of the jaw and downward along the neck. When I saw it, there was a soft, flaccid, baggy enlargement of the part, without any external or general signs of inflammation. I looked upon it as cystic and advised its removal. On attempting to carry out this practice I found no signs of a cyst wall, but simply a collection of a thin, watery, but highly albuminous fluid in the deep connective tissue of the neck. Indeed, when an incision had been made into the swelling and the fluid was evacuated, I never saw nor made a more perfect dissection of the submaxillary and digastric spaces than then showed itself. The fluid had clearly been poured out into the connective tissue of these deep spaces and there was no cyst wall. I washed the cavity out with iodine water and introduced a drainage-tube, and under the kind care of Dr. O'Meara of Sutton Bridge, Lincolnshire, the case subsequently did perfectly well, and no return of trouble has taken place.

It is quite possible that at the present time the tongue of this child, being large and coarse in appearance, might be mistaken for a case of macro-glossia or one of the forms of hypertrophy. No one, however, who recognizes the peculiar cystic appearance of its surface should mistake it or fail to recognize its nævoid origin.

Such cases as this have doubtless been described by authors as examples of vesicular disease of the tongue.

Nævi of the tongue do not, however, more than nævi of other parts, always undergo degenerative changes, although, when they do, they for the most part assume such modifications as of necessity result from the surface being cutaneous or mucous. Such nævi will probably require treatment.

Congenital Tumors of the Tongue other than Nævi.

These do occur, though rarely, and they may appear as outgrowths, warty or otherwise.

I have seen a warty growth covering the dorsum to the extent of a sixpence, and a growth as large as a rice-seed projecting as an outgrowth.

I remember also cutting off from the dorsum of an infant's tongue a pedunculated fibro-cellular congenital growth the size of a pea, and a good recovery followed.

In removing these pedunculated growths it is well to cut well into their bases, since cases have been recorded in which a return after removal has taken place.

Congenital tumors of a deeper kind may likewise occur, though none have come under my notice. A remarkable instance of such was recorded by Mr. Hickman in the twentieth volume of the *Pathological Society's Transactions*, in which, sixteen hours after birth, an infant was suffocated by a growth on the base of the tongue, made up of hypertrophied racemose glandular structures normally existing in the part.

Amongst the congenital tumors of the tongue must likewise be mentioned the existence of gummata in the subjects of hereditary syphilis.

Ichthyosis of the Tongue.

This peculiar disease of the tongue, to which the attention of surgeons was first drawn by Mr. Hulke in 1864 (Clin. Soc., 1868), is now generally recognized, although it is often known as "psoriasis." It is met with in several forms. In the *least* common variety the papillæ themselves seem to be hypertrophied and the disease appears as a coarse tongue, in which the papillæ are very large and in some cases covered with a dendritic, horny epithelial covering. In the *more* common kinds the surface of the tongue wholly or in part assumes, on the one hand, a smooth and bluish-white appearance, tessellated in a small or large pattern and delicately furrowed, with an absence of papillæ, or, on the other hand, it presents a more or less extensive whitish or yellow raised plaque made up of finer or coarser epithelial elements with a uniform surface, the parts when wet having a wet white-kid or yellow wash-leather aspect and a harsh feel, and when dry a brown appearance and a horny touch.

These three forms of disease may well be called, as suggested by Mr. Henry Morris, the *papillomatous* (Fig. 217), *smooth tessellated*, and *raised plaque* varieties.

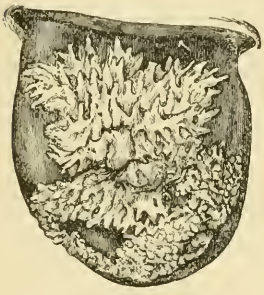
The disease is generally met with in subjects of middle age, although I have seen it in a woman as young as twenty-two; and it is more common in men than in women. It is in the majority of instances confined to the tongue, but in about one-third of the cases the buccal membrane is implicated as well.

It is very frequently associated with cancer, as in four out of the last ten cases I have noted, and in thirteen out of twenty-seven tabulated by Mr. Morris; it is said by some

authors always to lead up to it. It may or may not be found complicated with syphilis, but that it has a syphilitic origin can with some confidence be denied.

In one instance I found it associated with elephantiasis arabum of the legs and genitals. It was in a gentleman æt. 42 who had had the elephantiasis for ten years and the ichthyosis of the horny type much longer. It is met with in the temperate, but more frequently in the reverse; and it is as often as not found in those who do not smoke. It is a slow, insidious disease, and is rarely recognized, except by accident, until it has assumed a very marked type or become the seat of changes which suggest or characterize epithelioma.

FIG. 217.



Papillomatous Ichthyosis of Tongue.

The microscopical features of this disease are somewhat characteristic; they have been well described in the following report, made by my friend Mr. Symonds, of a specimen which was taken from Mr. B.——, æt. 64, 1882, in whom the ichthyotic disease had existed for twenty years and the cancer for seven months:

"The microscopical examination shows the papillæ to be much wasted, their arrangement resembling more that in the skin than in the tongue.

"The superficial layer of epithelium is very much thickened. The deeper layer varies in different parts. The cells are seen with a higher power to become altered and to be mingled with those of the mucosa. As the epithelioma is approached the limit is more marked for some distance, and the processes are shorter until the epithelial ingrowths are reached.

"The mucosa is infiltrated with crowds of nuclei. They diminish rapidly toward the epithelioma, but remain fairly abundant in the opposite direction. This diminution of nuclei, with increased definition of the basement membrane toward the epithelioma, is a striking feature in the sections."

TREATMENT.—It has been already stated that the majority of the cases of this disease do not come under the notice of the surgeon until the affection is a confirmed one, and under these circumstances it can readily be understood why the affection has been pronounced incurable. If seen earlier and treated, there is some reason to hope that benefit might be derived from treatment, if not a cure brought about.

This hope is supported by the assertion of those who tell us that they have seen cases of so-called psoriasis (not syphilitic) of the tongue cured; and I am sure that in several examples of ichthyosis I have found arsenic as an internal remedy, boracic acid or chlorate of potash as a local one, and as near an approach to milk diet as possible, with a total abstinence from wines, spirits, and smoking, highly beneficial.

In cases of advanced disease it is difficult to find patients who will submit for a sufficient period to this treatment, but in others, where it is met with in its early stage, the treatment would not be of necessity so prolonged. I am, however, convinced of its value and would urge its adoption.

In confirmed disease I know of nothing but the excision of the organ, wholly or in part, that can offer any prospect of effecting a cure; and if the pathological doctrine be correct that this disease always ends in cancer, there can be no difficulty about the course which should be taken. I think, however, at present it may with some confidence be asserted that this positive opinion is "not proven;" and under these circumstances, whilst the surgeon is justified in not rushing into operative interference in all cases, he should so watch the case as to be prepared to take steps for the complete removal of the affected organ as soon as he can see that active changes are occurring in it or anything like an ulcerative or degenerative change makes it appearance.

If the surgeon should err, let him do so on the side of early interference rather than that of delay, for it must be added that when a cancer attacks a tongue the subject of ichthyosis, it usually develops rapidly; and when the disease returns after removal, it does so more commonly in the submaxillary or cervical glands than in the part. The return growth, moreover, always display great malignancy.

In connection with this subject of ichthyosis of the tongue and its close association with cancer I should like to record the following fact:

In 1879 I saw a gentleman æt. 57 who was the subject of congenital ichthyosis of his skin, with an ulcer on his foot of six years' standing, which became cancerous and had to be removed.

This gentleman was one of nine, the eight being women, and four of these eight had

the same ichthyotic disease. The mother of these nine had the same disease, and her father before her. The gentleman himself was married and had six children, three boys and three girls. Two of the boys were similarly affected.

Inflammation and Suppuration of the Tongue.

Inflammation of the tongue, when deep-seated and general, is a grave affection, since the swelling which accompanies it is often so sudden and severe as to threaten life by suffocation. Such cases are, however, rare; I have seen but one.

I say this excluding from consideration those cases of sudden enlargement of the tongue the result of salivation from mercury or iodism, as in a case already reported. In these the symptoms, though severe, as a rule subside rapidly under local treatment and on the removal of their cause.

In rare cases, however, the tongue may slough off after ptyalism.

Inflammation of the tongue, when local, may be acute or chronic. It may follow an injury or come on without any other asignable cause than cold or exposure. It may begin as a sudden swelling of one-half of the organ, associated with constitutional symptoms of fever, etc., or it may show itself simply as a chronic enlargement of the part, with few, if any, general symptoms, and no more local, than are to be explained by the mechanical enlargement of the organ.

The disease, however, under both circumstances, is not dangerous, since it is well amenable to treatment and has a tendency toward recovery. I have seen many examples of this affection, and in all a good result took place.

Treatment.—When acute inflammation attacks the tongue as a whole and threatens life by suffocation, free puncturing or free incisions made in a vertical direction into the organ may be required, these openings being made with the view of relieving mechanically the turgid condition of the vessels and of giving exit to the inflammatory fluids which infiltrate the part. Serious hemorrhage may, however, at times follow these incisions, and in a case I witnessed of the late Mr. Poland's the result was nearly fatal.

In more local inflammations the benefit of puncturing the swollen part is very great—in the early stage to let out the serous fluids, and in the later to let out pus.

By way of medicines, salines and tonics are beneficial; but the disease has a tendency to get well by natural processes.

Hydatid Cyst in the Tongue giving Rise to Suppuration.

The possibility of a chronic cystic enlargement of a tongue, as of other parts, being due to the presence of an hydatid should always be in the mind of the surgeon, and more particularly when the enlargement is painless and gives rise to trouble mainly from mechanical causes. Also when a chronic, painless globular tumor has existed in a part for some time, say months, and then suddenly increases, the possibility of the swelling being due to the presence of an hydatid which has died and given rise to suppuration should be entertained, for hydatid tumors in their early stages, in the tongue as elsewhere, give rise to symptoms of a mechanical kind, and at a later period, when they die, to suppuration.

I have seen two cases of this affection; one occurred in the person of a middle-aged patient who had a chronic cystic enlargement of one side of the tongue. When the cyst was punctured, a globular hydatid escaped, and a good recovery ensued.

The second case occurred in 1881, in the person of a girl æt. 17 who came to me with a *central* cystic swelling of the tongue of seven or eight months' existence. The enlargement had been quite painless and felt like a tight globular tumor embedded in the tongue.

I punctured the swelling with a lancet and evacuated a collapsed hydatid cyst floating in pus, and a good recovery took place.

In the first case related the hydatid was turned out entire; in the second, the hydatid had died and had given rise, as any foreign body might, to suppuration. A cure in both cases took place as soon as the foreign body was removed.

Chronic Superficial Glossitis or Smooth, Glossy Tongue.

A smooth glazed tongue is often met with in practice, and there can be little doubt as to its being the result of a chronic inflammation of the mucous membrane of the organ. At times it is associated with ulceration. This inflammation is in many cases due to the heat or irritating influence of a hot pipe, cigar, or spirits.

It is well described by Mr. F. Clarke (*Diseases of Tongue*, pp. 159–161). It shows itself in patches more or less oval or oblong, of a deep red color and raw aspect, the other portions of the tongue presenting their natural appearance. The surface of these patches is smooth and glossy, though at times ulcerated. The tongue itself is occasionally swollen, and where the disease has existed for some time the patches feel thickened and as if elevated. Should the disease be checked in its progress, a complete recovery may ensue; but more commonly the patches remain smooth and shining or become the seat of a white patch.

In Preparation 1672[75], Guy's Museum, there is an interesting example of the affection, which occurred in a man æt. 49 who was admitted with pemphigus and erysipelas in March, 1878, and who gave a clear history of syphilis five years previously.

The preparation, as described by Dr. Goodhart, shows that the tongue was changed in appearance completely. Its surface, in place of being rough-looking, had lost all its papillæ, even the circumvallate, the whole being scarred over with smooth cicatricial tissue. The mucous covering of the tongue was thicker than normal, smooth, and white. At two spots were ulcers, one the size of a threepenny piece, with an indolent, unhealthy surface, the other larger and more superficial, healing. The tongue was not fissured.

Microscopically, these patches "are either entirely denuded of epithelium or it is reduced to an extremely thin layer, and the papillæ are obliterated by distension." Pathologically, the disease "appears to be a chronic inflammation of the mucous membrane which has gradually produced complete alteration in the characters of the epidermis and thickening of the corium and submucous tissue" (Butlin, *Med.-Chir. Trans.*, vol. 61).

The disease is constantly the precursor of a cancer.

Ulceration of the Tongue.

In a clinical point of view it is expedient to divide the ulcers of the tongue into the *superficial* and *deep*, since, in a general sense, the superficial are local, simple, and readily curable, whereas the deep—which are due to the breaking down of inflammatory, tubercular, syphilitic, or cancerous elements—are complicated, difficult to diagnose and treat, and, moreover, are dangerous.

The **superficial** sores include the aphthous and dyspeptic ulcers, those associated with chronic glossitis, ulcers excited and kept up by decayed or ragged teeth, as well as some due to syphilis, congenital or acquired.

The **deep** ulcers are always either syphilitic, cancerous, or tuberculous.

Superficial Ulcers.

The ordinary **aphthous** inflammation of the tongue is a common affection, and is met with in children and adults as a result of irritation of the stomach or intestines from dietetic or other causes. In feeble subjects the white aphthous spots may ulcerate and thus become the source of much trouble, and the ulceration may be extensive, though rarely deep. In cachectic patients the parts may slough.

The TREATMENT of these cases must be mainly determined by the cause, but in the majority a lotion of chlorate of potash, or boracic acid of five grains to the ounce of water, and the internal administration of the same drugs, with or without bark or the mineral acids, is generally sufficient to bring about a cure, though in feeble subjects this may be slow.

In the more limited affection the local application of the nitrate of silver often acts very beneficially, and in the more chronic quinine is of great value.

The Simple or Dyspeptic Ulcer of the Tongue.

This form of superficial ulcer of the tongue may be the sequel of the aphthous, but more commonly it begins as an ulcer, a result of chronic glossitis, which steadily spreads. It rarely, if ever, dips into the muscular tissue of the organ, but is confined to the mucous membrane covering it. The ulcer may be inflamed, indolent, sloughing, or irritable; indeed, it may vary as may any ulcer in another part of the body; and if chronic, it will be indurated. Its surface, however, will almost always be smooth, and it will never display the irregular or deeply-excavated appearance of the deep sores; it will, moreover, almost always be seen upon the dorsum of the tongue, although in exceptional instances it may spread downward.

Treatment.—The only sound principle of treatment is a soothing one, and the chief good is to be gained by means of diet. This is to be regulated in the most careful manner, and all food should be forbidden that can possibly irritate. Milk food, when it can be taken, is the best, and with it it is well to give alkalies, such as lime water, bicarbonate of potash, or chlorate of potash, and at times opium in small doses. Animal broths are beneficial; but little meat should be allowed. All beer and spirits should be interdicted; and when stimulants are absolutely necessary, they should be given as wine well diluted.

Locally, the lotion of boracic acid or chlorate of potash is beneficial, and caustics are rarely required. Of tonics the barks are the best form, but at times the mineral acids are of value.

Ulcers Originating from Local Irritation.

These are very common in the tongue, and the fact is due to the restless mobility of the organ and the necessary friction which it must receive from any sharp process, of a broken or decayed tooth, or any edge of rough tartar, or even from the presence of an exostosis of the lower jaw. I have known an ulcer due to the last cause to be looked upon as cancerous.

These cases are at times very troublesome and obstinate unless their cause is recognized, and they may, and do, without doubt, often become cancers.

They may show themselves as mere blisters or superficial ulcers, the other part of the tongue being healthy, but in chronic cases the local sore may be indurated and thus simulate a cancer. In the case of a woman aged 40 the ulcer had existed two years.

Some subjects are more susceptible to irritation than others, and I have known a patient have repeated blistering and ulceration of the tongue from the irritation of a rough decayed tooth after sleeping on the affected side. The mere weight of the tongue against the tooth and the unconscious friction between the two parts when in contact proved enough to produce a blister in the soft parts.

Treatment.—The mere knowledge of the cause of this affection suggests the remedy—namely, the removal of the cause, the removal of the point of irritation when possible, and the extraction of the tooth when nothing less is sufficient. Indeed, as a general rule of practice, the surgeon should always advise the removal of any local source of irritation from the tongue, as from any other part of the body, for such is, without doubt, the cause of the majority of local cancers.

Infiltrations and Deep-Seated Ulcers of the Tongue.

I have of necessity grouped these cases together, for the majority of the deep-seated ulcers of the tongue begin as local infiltrations and are due to the subsequent breaking down of the infiltrated and infiltrating material.

The group consequently includes cases of syphilitic disease, of epithelial cancer, and of tubercular disease of the tongue, each of which claims a distinct notice.

Syphilitic Disease of the Tongue.

This shows itself in many ways and under many circumstances. Thus, it may occur as a *congenital affection* and appear either as a mucous patch on the tongue associated with other constitutional symptoms, or as a deep fissure, as recorded by Dr. Barlow (*Path. Soc. Trans.*, vol. 31) or as a superficial ulceration. Of the former kind I have seen several examples; of the latter but one, and that through the kindness of my colleague, Dr. Goodhart, in whose practice it occurred.

A full report of the case may be read in the *Guy's Hospital Reports* for 1883.

As an acquired disease, syphilitic disease of the tongue shows itself either as a mucous patch or as a more or less extensive local infiltration of the tongue with gummous deposit, the breaking down of which leads either to superficial sores, to fissures, or to deeply excavated irregular ulcers, and later on to the indurated and irregular cicatricial tongue.

In some instances the gummous material is either poured out soft or as a solid which soon breaks down, under both circumstances appearing as a cystic enlargement in the body of the tongue. I have seen, in some cases, four or five of these cystic swellings in a tongue thus affected, and on opening the same have given exit to a thin fluid. The enlargements appear as single or multiple globular tumors in the body of the tongue.

When the disease occurs in the shape of *mucous patches*, it is usually associated with other symptoms; the patches are commonly multiple and are for the most part situated on the upper surface and edges of the organ. They appear either as moist papules with whitish tops, as red, circular, or irregular excoriations, or as granulating surfaces projecting as white, moist, raised growths. The mucous patches in the tongue are precisely like those seen in other mucous membranes, and, indeed, are identical with them.

They may occur with the first onset of constitutional symptoms or not show themselves till a remoter period of syphilitic inoculation. They are very prone to reappear after their supposed cure.

When syphilis attacks the tongue as a local infiltration of gummous deposit, it does so usually long after the primary inoculation, even after twenty or more years.

It may do so as a single or more commonly as a multiple, more or less rounded infiltration of the submucous or muscular tissue of the tongue, and the swellings may be pea-like or nut-like; at first these swellings will be hard, but as time progresses changes will occur in them. If allowed to run their course, they will enlarge and break down, open and discharge; if treated, they may soften and be reabsorbed or wither and dry up, the latter change being very rare.

When this affection is allowed to run its natural course, the swelling will enlarge and subsequently break up; the hard lump will increase and become softer; the soft parts covering it in will redden, inflame, and open either by an ulcerating or sloughing process; and when the contents of the lump have been discharged, either a ragged cavity will be left to granulate or a fissure to heal. The edges of the cavity or fissure are under all circumstances perpendicular and sharply cut.

The cavity, when the parts have opened by a sloughing process, will be more or less ragged, according to the amount of destruction of the tissue of the tongue, and it will present a surface which will vary according to the stage of the disease. When looked at during the period of sloughing, the dead tissue infiltrated with the *yellow* infiltrating material, of a wet, wash-leather appearance, will readily be recognized; and when seen at a later period, the irregularly excavated cavity with sharply-cut perpendicular uninfiltrated edges will generally enable the surgeon to diagnose the disease from the one for which it is often mistaken—a sloughing cancer. The common want of enlargement of the lymphatic glands in this specific affection of the tongue is another help to diagnosis. At a later period, when repair has taken or is taking place, an irregular, yellow-white cicatrix (leucoma) will be seen, and the tongue eventually will show marked evidence of the destructive processes of which it has been the seat, wasting of some parts of the tongue, scarring of others, mixed up with irregular cicatricial tissue, being the chief characteristics of a repaired syphilitic tongue.

In tongues that are brought rapidly under the influence of appropriate treatment, the changes that have now been described may be considerably modified. Thus, the nodular infiltrated mass may soften and the deposited material may be reabsorbed. The tongue itself will become supple and more natural, and a cure may take place—a cure, however, which in some cases is attended with a wasting of the portion of tongue that was infiltrated, or a loss of the natural papillary tissue upon the surface of the tongue which corresponds to the seat of infiltration.

What, however, is of far greater importance to remember is that a tongue which has been the seat of syphilitic disease frequently becomes the subject of a cancer. The altered nutrition brought about by the irritation of the one affection encourages the development of epithelial disease. A relapse of this affection after an apparent cure is also very common.

Treatment.—When the diagnosis of this many-faced disease has been made, the line of treatment to be adopted is not difficult to lay down, for there can be but little doubt that some mercurial medicine is the most certain drug to employ where there are no indications against its use; and, on this being rejected or found wanting, the iodides of potassium, sodium, or ammonium, in gradually increasing doses, are to be used.

The disease must be dealt with as a general, and not as a local, one; and the local affection is to be regarded as one of the manifestations of a constitutional disorder which may appear in other seats, though as yet it may not have done so.

When mercury is prescribed, the perchloride in doses of one-sixteenth of a grain in bark may be given, or, what I like as well, a pill of half a grain of the green iodide of mercury twice a day. In both cases the dose should be gradually raised to double the strength indicated.

When mercury is contraindicated on account of the patient's cachectic or feeble con-

dition, the iodides may be commenced at five-grain doses and steadily increased week by week by a grain up to twelve-, fifteen-, or twenty-grain doses three times a day. The iodide of sodium may be at times substituted for the iodide of potassium. Tonics are often required at the same time, with good simple food, fresh air, and regular habits. Stimulants should be given very sparingly, and all smoking should be strictly prohibited. As a local application the lotion of boraic acid or chlorate of potash gr. x to the ℥j of water is of value, and the recommendation of Mr. H. Morris to rub a piece of blue-pill mass once or twice daily over the surface of the sore is worthy of adoption. When the disease has apparently disappeared, the treatment must be continued for some—possibly for six—months, this practice being necessary to guard against a relapse. The routine practice of applying the nitrate of silver to these sores cannot be too strongly condemned.

In the "lumpy tongue," in the stage in which the lumps are softening, I have found the simple operation of puncturing the tumors to be of great use by procuring the escape of the contents of the lumps, which are often serous, thereby relieving tension and certainly expediting the cure.

In cases of long-standing disease the fear of the tongue becoming the seat of cancer should ever be before the surgeon, and the fact of a tongue having been the seat of an old syphilitic affection should tend rather to support than to weaken the view of a doubtful excavated ulcer of the tongue being of a cancerous nature. At any rate, where the doubt exists, let it rather encourage surgical interference than prolonged medicinal treatment; for in a clinical point of view a chronically affected syphilitic tongue had better be occasionally removed than a cancerous one left to run its course.

Cancer of the Tongue.

This distressing disease is met with in about five out of every hundred cases of cancer, and is an affection of adult life. An analysis of 102 consecutive patients admitted into Guy's Hospital, and seen by me, shows that 80 out of every 100 affected by it were over the age of forty-five; 12 were under forty years of age; 27 between forty-one and fifty; 31 between fifty-one and sixty; 25 between sixty-one and seventy; and 7 over seventy years of age. This disease may, however, occur as early as twenty-seven. It is more common in male than female subjects, in proportion of 80 to 22.

The disease is *always* of the epithelial form, and is essentially an isolated infiltration of the papillary or mucous surface. It usually shows itself as a blister, crack, ulcer, wart, or superficial tumor upon the tip or side of the tongue, and is in the majority of cases single. It then breaks down and discharges, leaving a more or less ragged, irregular, excavated sore with raised, indurated, infiltrated, and mostly everted edges.

The disease is at first always local, but later on, when allowed to take its course, it will spread and involve the floor of the mouth, fauces, gums, or jaw-bone. It will, moreover, always, sooner or later implicate the lymphatic glands.

At times the diseased parts slough more or less extensively, and in a case which was under my care in 1866 the whole organ sloughed off before the man died. It affects one side of the tongue as much as the other, and is at times central. But, wherever it may commence, it will soon involve neighboring parts.

It originates at times without any definite cause, but in the majority of cases it is excited by some local irritation, such as that caused by a broken or rough tooth, a hot pipe, an antecedent syphilitic affection, or the disease which is now known as ichthyosis.

It may originate also in a scar on the tongue, as it is well known to do in scars of other parts. In 1880 I saw a case in which the disease had attacked the tongue of a man æt. 57 who had bitten off its tip five months before in an epileptic fit, and a second in 1875, in a man æt. 70 who had injured his tongue by a fall two years before.

Diagnosis.—Any localized *infiltration* of the papillary or mucous covering of the tongue, however limited it may be, in a patient over forty, should be suspected to have an epithelial origin; and should this be found in a part of the tongue in which no local source of irritation can be discovered, the suspicion becomes a certainty.

Should the infiltration coexist with ulceration and a local source of irritation be made out—such as a broken or rough tooth—the probabilities of its being due to this local irritation may be regarded as great; but should the disease fail to undergo a rapid cure upon the removal of its supposed cause, the conclusion should be drawn that the disease is cancerous.

When a tongue has been the seat of a chronic syphilitic affection, and more par-

ticularly is one in which a series of relapses has taken place, with uncertain intervals of apparent convalescence; and when it presents an indurated, infiltrated tissue, with a more or less excavated, ulcerating, or sloughing cavity, with irregular, everted, and raised, rather than sharply cut and defined, edges,—the diagnosis of the disease being cancerous is highly probable; and when with these symptoms the lymphatic glands beneath the jaw are found enlarged, the diagnosis becomes a certainty.

When, again, this local infiltration, with or without ulceration, is found in a tongue which has been the seat of an old syphilitic leucoma or the subject of that peculiar disease of the papillary mucous membrane known as ichthyosis, there should be no question as to its true nature; for it should be accepted as a fact that chronic syphilitic as well as chronic ichthyotic disease renders the tongue peculiarly liable to undergo changes in its epithelial elements which most commonly reveal themselves as epithelial cancer.

Mr. Morris has recorded, in an able paper on this subject,[1] the fact that out of 55 cases of cancer of the tongue, in 13, or about one-fourth, the organ had been the seat of ichthyosis. I am quite prepared to support him in this average.

Treatment.—There is but one form of treatment of cancer of the tongue that can be recommended with any confidence, and that is the removal of the disease by some surgical operation. And there is but one period at which this operation is likely to prove successful as a cure, and that is in the early stage of the disease when the cancer is local and when it involves no other tissues than those in which it was primarily placed.

When the disease has extended beyond these limits and through the lymphatic channels has implicated the lymphatic glands, the prospects of a cure are not favorable, even if they can be said to exist, since, whilst the glands that lie along the ramus of the jaw may be readily removed, those that lie buried behind the angle are beyond the surgeon's reach, and to remove some, and not all, of the infected glands, is a futile proceeding.

When a local cancerous disease is removed, it should be a rule of practice that all enlarged lymphatic glands should be removed likewise; and this rule is as applicable to the tongue as it is to other parts.

As to the best means for the removal of a tongue, wholly or in part, surgeons are found widely to differ—one advocating strongly the removal by the knife or scissors, whilst others as strongly urge the use of the écraseur, employed either as a crushing or as a burning force. The chain or wire instrument is used in the crushing, and the platinum wire heated by means of a galvanic battery as the cautery écraseur. For many years I employed the galvanic écraseur and found no fault with it; of late I have again resorted to the chain or wire instrument, but have had no reason to be better satisfied with my results. I altered my practice in deference to a strong opinion that has been given by some surgeons as to the dangers of the galvanic and greater safety of the simple écraseur, but this opinion does not find support from my facts.

With the view of testing this point I have extracted from our Guy's Hospital records 46 consecutive cases of operation, and find that of 36 operated on by the galvanic écraseur 4 died from the operation, or 11.1 per cent., and 4 from other causes. Of 7 cases operated on by the chain or wire écraseur, 1 died from the operation and 1 from the disease. Of 1 removed by excision and 2 by ligature, none died. Of the whole number of 46 cases, 5 died from the operation, or 10.8 per cent., and 5 from other causes.

Of the 5 fatal cases from the operation, 2 sank on the eighth day—1 from pleurisy and the other from broncho-pneumonia; 1 on the twentieth day from broncho-pneumonia, and 1 on the twentieth from exhaustion and repeated small bleedings. The single fatal case after the use of the chain écraseur was on the twelfth day from broncho-pneumonia.

One of the 5 cases that died after the operation, though not from it, sank on the thirty-sixth day, from recurrent disease and gangrene of the lung; 3 on the fifty-third, forty-eighth, and thirty-second days, respectively, from recurrent disease and exhaustion; and 1 on the thirty-eighth day, from recurrent disease and pyæmia.

It will be thus seen that *three* out of the 8 cases that died after the use of the galvanic écraseur, and *one* out of 2 cases that had been operated on with the chain or wire instrument, or *four* out of the whole number of 46 cases of operation, or 8.7 per cent., died from lung complication; and the records of the pathologist tell us that such a complication is by no means infrequent when no operation has been performed. At any rate, evidence is wanting to show that this lung complication is more common after operation than it is without, or when it follows operation that the operation has anything to do with the lung disease.

It is true that the inhalation of fetid or septic elements, when the tongue is slough-

[1] *Trans. of Med. Soc.*, 1882.

ing either by natural processes or as a consequence of operation, must of necessity be prone to bring out this lung trouble; but this fact, instead of being adduced as an argument against operative interference, may fairly be used as one in its favor, since to get rid of the sloughing and fetid organ is one of the surgeon's aims in an operation, and to do so in the quickest, safest, and simplest way is his object.

When the galvanic écraseur is used and the cauterized tissue is rendered aseptic by means of a plug of iodoform gauze well pressed upon the surface after operation, or when the charred or bruised surface, after the use of the galvanic or wire écraseur, is kept sweet by the repeated application of the colloid styptic—which, Mr. Morris tells us, "tans the surface of the wound, causes little or no slough, and corrects the fetor of discharge"—there is less fear of any evil result from septic causes than there was before the disease was removed.

There is, consequently, no argument against the use of the écraseur that has any weight.

Whilst, therefore, for the removal of a tongue, wholly or in part, I have a preference for the écraseur, and for the galvanic over the wire or chain instrument, I am ready to admit the value of excision by means of scissors or the knife, or of any of the different modifications of these operations which the ingenuity of different surgeons has suggested, for I believe that in individual cases one form of operation may be more applicable than another, and that in the hands of any surgeon the mode of operating he excels in is the best for his patient.

I may say, however, that I have not yet seen a case in which the division of the lower jaw as taught by Syme has been required.

Most tongues can be removed through the mouth, however extensive the disease may be, if the organ be well drawn forward by means of a thick ligature introduced through the body of the tongue, and if it is freed from its attachment to the lower jaw and fauces by the division of its mucous membrane attachments. There is no objection to the removal of a whole tongue in halves, though there is no advantage in so doing. If more room should be required, this is best obtained by means of an incision across the cheek from the angle of the mouth, the écraseur being then worked sideways.

Bleeding during an operation need cause no alarm if the operation be performed leisurely, since it can be speedily controlled by the torsion of the divided artery if the tongue be well drawn forward; in many cases the simple drawing forward of the tongue suffices to bring about this result, the artery receding into the muscular tissue.

I can see no advantage in adopting the practice of Demarquay of ligating before the operation the lingual arteries, although when severe bleeding takes place after the operation the practice may be good. The operation, however, may be performed, in cases in which the removal of the disease is inexpedient or impracticable, with the view of bringing about wasting of the diseased organ. The division of the lingual gustatory nerve on the inner side of the lower wisdom teeth, as practised by Hilton (1850) and Moore (1861), for the purpose of relieving pain, is also a practice to be strongly recommended.

It must likewise be recorded as one of the advantages of excision of the tongue that should a return of the disease take place it is more likely to do so in the lymphatic glands of the neck than anywhere else. Under these circumstances, the patient is relieved of his distressing local affection and sinks slowly and comparatively painlessly. I have often heard with pleasure, even under these miserable conditions, expressions of gratitude from patients who have gone through the operation—gratitude for the sufferings they have been released from and spared.

I may also add that it seems probable that life is materially increased by the operation. In some cases I have to record, the increase was great, and even when a return takes place there is a degree of increase. Mr. Morris states that out of 15 cases operated upon the average duration of life was sixteen months, whereas in those which no operation was performed it was but ten and a half, only two cases having been known to have lived eighteen months.

In the cases I now record a decided increase to life must be admitted, and particularly if we take the average of life with this disease when left alone as ten and a half months.

In 1866 I removed the anterior half of the tongue from W. P.——, æt. 60. The patient remained well, so far as the tongue was concerned, for *fifteen* years, when disease reappeared in the scar. The patient at this time was suffering from hemiplegia and senile decay, of which he died.

In 1872 I removed from Mr. S——, æt. 45, half his tongue for a local cancer. He reported himself to me as well *ten years* later, 1882.

In 1871 I removed a local cancer from the tongue of Mr. R. W——. No return ever took place, though the patient lived *five years* and died from anæmic gangrene of the foot.

In 1870 I operated on H. S——, æt. 70, and removed a cancer, with the anterior two-thirds of the tongue. *Three and a half years* later he reported himself as well.

In 1869 I removed a portion of the tongue from H. J——, æt. 42. He lived *two years* and had no return, and died from lung disease.

I can trace two cases now alive and well who have been operated on for *two years*, and two who are well one year after operation, and have records of three who survived the operation for eighteen, eighteen, and eleven months respectively.

Altogether, out of a somewhat limited personal experience, the above record of facts must be regarded as encouraging, clearly showing the possible benefit of the operation, and the probability of a cure being obtained in a larger number of cases if the operation were undertaken as soon as the diagnosis of the local disease has been made.

Tubercular Ulceration of the Tongue.

It is right that this disease should have a special notice, since it is neither common nor generally recognized. It has, however, features of its own which claim attention. I have seen several examples of it, but have records of only two.

Symptoms.—It occurs in feeble subjects, and begins as a papule which soon ulcerates and in spite of treatment passes into a sore or fissure. A second and a third sore soon follow the first and run the same course, the same in its obstinacy and the same in its tendency to form a fissure or excavation. When it presents the latter appearance, the surface of the sore will be that of an old indolent ulcer on other parts; its base will be more or less infiltrated, but never hard, like that of cancer; and its edges, though infiltrated, will not present the sharply cut aspect of the syphilitic fissure or the elevated everted irregular border of the cancerous; the secretion from the sore is often cheesy. In fact, the sore is neither like the syphilitic nor like the cancerous, and yet, for want of its recognition, it is usually taken for one or the other.

In one case the ulcer appeared as a fissure with an indurated base and infiltrated edge. In another the ulcers were irregular, their edges but little thickened or hardened, and their floors were formed by a soft-looking cheesy material. Add to this that the cuticular covering of the tongue was unnaturally glazed and red or livid, with numerous small superficial erosions, of similar type to the larger ones, affecting a large part of the surface, and the disease makes a picture which, once seen, is neither likely to be forgotten nor mistaken.

"Sections of the tongue showed that the cheesy material had invaded the muscular structures to some depth, and of the microscopical examination it is only necessary to say that it revealed a thick infiltration of the tissue by lymphoid cells, which were in many parts granular from degenerative changes."[1]

Altogether, the clinical and pathological features of this disease make up a picture which possesses characters of its own sufficiently marked to render its diagnosis tolerably clear.

Could the ulcerating surface have been well scraped and thus destroyed, it is probable that a cure might have been brought about, but this method of treatment could hardly have been carried out in such an organ as the tongue; at any rate, its removal answered well, as a speedy cure followed.

The case is allied to chronic inflammatory sores of other parts in which the inflammatory elements organize as granulation tissues and dip down deeply into the parts around. In such nothing less than the complete excision or scraping of the infiltrated tissue will bring about a cure.

Other tumors of the tongue are met with, and I have recorded some in the *Guy's Hospital Reports* for 1882, vol. xxvi.—more particularly an example of blood cyst at the base of the tongue, and another of adenoma. Such cases are, however, rare.

The Operation for the Removal of a Tongue.

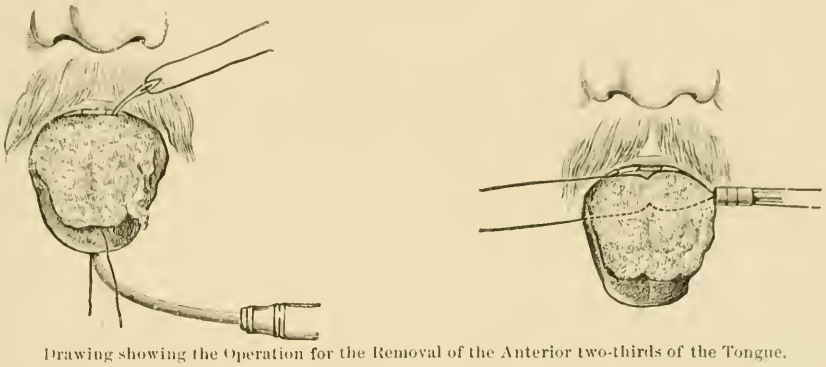
This operation is comparatively a successful one, about one case in ten dying. It moreover interferes but little with articulation. There are two good methods of performing it—one by means of the écraseur, galvanic or otherwise; the other by excision, effected by either a knife or scissors. As a rule, when the tongue is diseased, it is wise to remove the whole width of the organ; and under all circumstances care should be taken

[1] *Guy's Hosp. Reports*, 1883, p. 134.

to keep well clear of the disease. A portion of the tongue should be taken away only when the disease is very local.

To remove a tongue wholly or in part, the patient should be anæsthetized, and when the galvanic écraseur is used chloroform employed. The mouth should be kept open

FIG. 218.



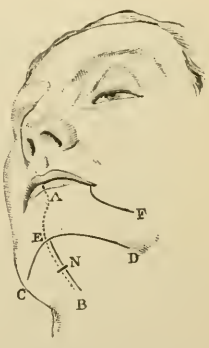
Drawing showing the Operation for the Removal of the Anterior two-thirds of the Tongue.

with a gag, and the tongue well drawn out of the mouth by means of a thick ligature passed through its substance; and this necessary proceeding will be much aided by the free division with scissors of the attachments of the organ to the fauces and to the lower jaw.

When the écraseur is used, one or more curved needles on handles should then be passed well behind the growth, to isolate it from the healthy parts and to prevent the wire or chain of the écraseur slipping forward. The écraseur is then to be adjusted behind the needles, and, being made secure, *slowly* screwed home. Should the operator prefer to divide the tongue down the centre as a preliminary measure, each half of the organ may be removed separately. When the scissors are used, the part to be removed should be snipped away slowly and all divided vessels twisted. Mr. W. Whitehead of Manchester warmly advocates this method.

The amount that can be removed through the mouth by these means is measured only by the appliances the surgeon has at his command to fix its posterior boundary. In the case figured above more than the anterior two-thirds of the tongue were removed, and by means of the curved needle shown in the drawing no difficulty was experienced in passing the ligature or in removing the organ. When the diseased tongue cannot be isolated and surrounded with certainty through the mouth, various expedients have been suggested. Professor Syme divided the lower lip and jaw in the median line to give room for the operation (A to B, Fig. 219). Regnoli of Pavia made an incision from the hyoid bone to the chin, and two lateral cuts from the anterior extremity of this along the lower border of the jaw (B to E and C to D, Fig. 219), dividing through to the mouth all the tissues that connected the tongue with the lower jaw at the symphysis, thereby giving abundant room to draw the tongue downward. Nunneley of Leeds introduced beneath the jaw, between its base and the hyoid bone, a sharp-pointed curved knife four inches long, and brought it out in the mouth at the frænum lingnæ (N, Fig. 219). With a probe guided upon this knife he then drew through the wound the wire rope of the écraseur, drawing a good loop through the mouth and withdrawing the probe, the two ends of the rope hanging beneath the chin. He then seized the tongue with forceps, forcibly pulling it out of the mouth, and pushed through the base of the tongue three long and strong pins, making their ends appear in its upper surface near the base and behind the disease. He then passed the loop of the écraseur behind the pins and drew it tight, thus completely encircling the whole organ. The process of removal then went on. Sir J. Paget has done away with the submental puncture, and gives freedom to the tongue by dividing the soft parts that hold it down at the floor of the mouth close to the bone, thus allowing the organ to be pulled well forward. At the same time, he rightly insisted that care should be taken to divide the tongue perpendicularly through its thickness, and not obliquely; this practice, however, is fairly guaranteed by the introduction of pins, as already mentioned. Collis of Dublin advised

FIG. 219.



Illustrating the Different Operations for the Removal of a Tongue.

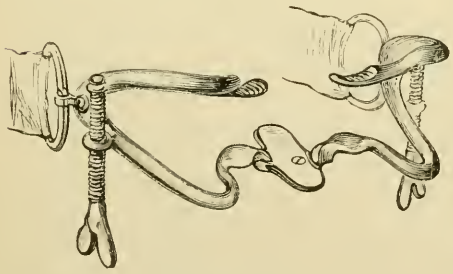
that the cheek be laid open from below its angle to give room for manipulation when the disease is far back (F, Fig. 219). By one or other of these means room can be obtained to free the tongue from its attachments, to isolate the growth by pins and remove it by the écraseur, wire rope being used when the galvanic cautery écraseur cannot be obtained. To isolate the disease, I have found the curved needle, as seen in Fig. 218, introduced through the base of the tongue, behind the disease, to be very valuable.

Fissures of the Palate.

The hard and the soft palates are liable to fissure, partial or complete, or both palates may be involved. It may be that the fissure appears as a mere notch in the alveolar process, in the line of junction of the superior maxillæ with the intermaxillary bone, as is seen so commonly in harelip, or it may pass backward toward the velum. On the other hand, the soft palate may show only a bifid uvula or a complete fissure. The fissures in the hard and soft palates are almost always in the middle line, although where they involve the alveoli they diverge as they involve one or both sides of the intermaxillary bone; in fact, they usually follow the line of suture, as seen in Fig. 187. Fissure of the soft palate alone is more common than that of the hard. Yet it is very rare for the intermaxillary bone to be so displaced, as seen in Fig. 193, without fissure of the palate. Mr. Mayland has recorded an exceptional example of this deformity (*Lancet*, November 24, 1883), and in a case I recently treated the girl had a transverse band half an inch wide joining the two sides of an otherwise complete fissure at the level of the palate bone. These malformations, when severe, interfere much with speech and give rise to much difficulty in sucking and deglutition, the food passing through the nose. To relieve this, Mr. Oakley Coles has ingeniously adapted a flap of india-rubber to the upper surface of the nipple of an ordinary feeding-bottle, which, when the infant sucks, rises up and fills in the gap. Where this cannot be obtained, the child should be fed from a bottle with a piece of elastic tubing on its nozzle to fall over the roof of the tongue. Partial fissures are of little importance.

Treatment.—When fissure of the palate coexists with harelip, the lip may be operated upon as usual, irrespective of the fissure. Operations for the repair of the fissure have till recently been put off till the child was of an age to give assistance to the operator. Billroth was the first to operate in infancy, and did so with success on a child twenty-eight weeks old in three operations. In 1868, Mr. Thomas Smith introduced to the profession a gag (Fig. 220) that holds the jaws open and depresses the tongue, enabling the surgeon (with the patient under the influence of chloroform) to undertake the operation at a very early period; indeed, Mr. Smith has quoted cases where he operated at three years of age (*Med.-Chir. Trans.*, 1868; *St. Barth. Hosp. Rep.*, 1871). It may generally be undertaken at the age of five in a healthy child, and I have performed it successfully at four years of age.

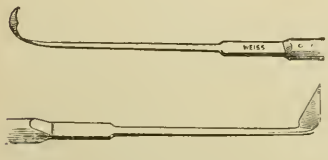
Fig. 220.



T. Smith's Gag.

Roux was the first who practised the operation with advantage, having in 1819 successfully treated a medical student for cleft palate. Dr. Mason Warren of Boston did also much toward encouraging the practice, but in this country there is no doubt that to Sir W. Fergusson is due the credit of having demonstrated the value of the operation and of suggesting improvements therein. In his chief paper, published in 1845 (*Med.-Chir. Trans.*), he showed "how the *levator palati* on each side had such free and uncontrolled action that whenever excited it drew the margin of the cleft outward and upward, and so tugged upon the stitches put in by the surgeon that ulceration in their sites was a most probable result." He therefore suggested the division of this muscle in all cases, and that of the palato-pharyngeus in some. He did this by means of a curved knife (Fig. 221) passed through the fissure, so that its point can be laid on the tissues immediately above the soft velum,

Fig. 221.



Fergusson's Knives.

midway between its attachment to the bones and the posterior margin and about halfway between the velum and the lower end of the Eustachian tube. The point is then thrust deep and carried half an inch or more backward and forward, so as to cut the levator palati. By these means the palate is paralyzed for a time, and so repair goes on with greater certainty.

For fissures of the hard palate much has been done in more recent times. Dr. Mason Warren in 1843 described the process of separating the hard from the soft palate with the view of its closure, though it has been left to Langenbeck, Billroth, Pollock, Avery, Lawson Tait, Annandale, T. Smith, and others to perfect the process.

Operation.—Chloroform is not necessary in a patient old enough to understand the necessity of being still and assisting the surgeon. In young children, with Smith's gag, it is an advantage.

The recumbent position, with the head sufficiently thrown back, is probably the best, although some surgeons make the patient sit. The operator should stand on the patient's

Fig. 222.

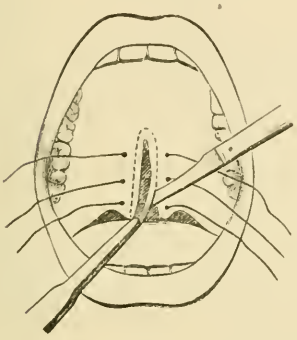
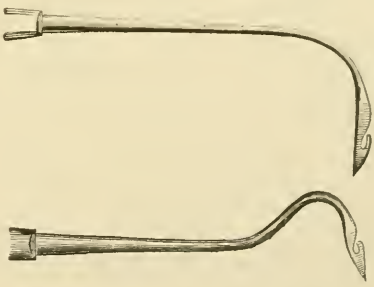


Figure showing the Paring of the Edges of Fissure after the Introduction of the Sutures.

Fig. 223.

Brook's Needle.



Needles employed in Fissured Palate.

right side or in front. The steps of the operation have been hitherto as follows: Pare the edges of the fissure, pass the sutures, paralyze the muscles, and fix the stitches. To pare the edges a blunt-pointed bistoury is generally used and a thin border of mucous membrane cut off from below upward, the bifid uvula being held by a tenaculum-pointed forceps (Fig. 222). The incision also should be made as clean as possible. When it is made from above downward, a sharp-pointed bistoury is needed. To pass the sutures, a corkscrew needle may be employed, or a curved needle flattened laterally (Fig. 223), with a slit in it for an eye, or an eye in the end. The lowest suture should be inserted first and both ends held, this practice facilitating the introduction of the others. The best material for sutures is fine gut; Mr. Smith uses horsehair for the lower stitches. I have rarely used anything but gut for all plastic operations since the year 1860, taking the precaution to select and to soak it in water for some minutes before using it.

If Sir W. Fergusson's plan of paralyzing the muscles be employed, it should be, as he advises, as a preliminary step to the operation. If Sedillot's or Pollock's plan be followed (Fig. 225, B), it may now be done by inserting a knife through the velum about a third of an inch from the highest suture and cutting along the posterior edge of the hard palate toward the free margin, but not through it. This is the course I have until recently adopted. The two pillars of the fauces may then be snipped with scissors. The sutures have then to be fastened, and the best plan is to run a perforated shot over the gut and clamp them, tying the ends of the gut in a knot, to prevent the possibility of their slipping. I usually begin at the highest. Care should be taken not to draw the stitches too tightly. "Sutures," says Pollock, "should hold, not draw, parts together, if union is to follow." The parts should be sponged as little as possible; and the less manipulation there is, the better, any irritation causing so free a secretion of mucus as to interfere greatly with the surgeon's proceedings. Rapidity in operating is, consequently, an advantage. When the parts require to be cleansed in the adult, iced water may be used as a

gargle; and with a child under chloroform the stitches may at times be inserted and the edges pared before any cleansing is required. In deep mouths, where difficulty is experienced in passing the sutures, a clever manœuvre suggested by Avery may be called for, and is illustrated in Fig. 225, B; one end of the gut C is pulled through the soft palate and the end passed through a loop of silk A inserted on the right side; on pulling the

FIG. 224.

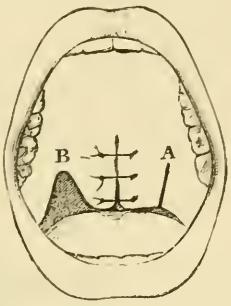
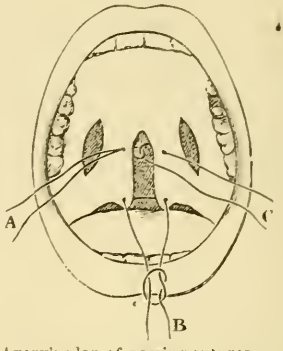


Figure illustrating Line of Incision. (Employed to relieve tension of the palate after the edges have been adjusted.)

FIG. 225.



A, Avery's plan of passing sutures.
B, Fergusson's plan of fastening sutures.

loop the end C will be drawn through the right side. When silk is used, the double reef knot, as shown at the lower part of Fig. 225, and generally adopted by Fergusson, is very serviceable.

In some cases I have been able to simplify the operation by altering its steps; that is to say, I have first introduced sutures through the soft palate, taking care to do so a quarter of an inch from the free border of the fissure, and secondly pared the edges, employing for this purpose a pair of scissors with short blades placed at right angles to their shanks, or a knife. By this practice the introduction of the sutures is an easy proceeding, and consequently very rapidly effected, and the bringing together of the pared edges can be readily accomplished.

To relieve tension of the parts, I now divide the soft palate laterally, as shown in Fig. 224, the side cuts (A) subsequently gaping, so as to appear as arches (B); in this way the muscles of the palate are completely paralyzed, and the soft palate itself appears as one large uvula.

I have performed the operation already described on many occasions, and with success. In none was there even a pinhole left. Its simplicity is very striking. It cannot, however, be applied in all cases.

The stitches may be left in for five, ten, or even fourteen, days, the amount of irritation being the guide to their removal. When union has taken place, the sutures only act as irritants; and in this as in all plastic operations they should be removed as early as possible with safety. During the process of repair the patient may freely take soft food, swallowing by no means tending to separate, but, on the contrary, to close, the wound. Stimulants may be given when desirable. The operation should be undertaken only in healthy patients; in the feeble it is almost sure to fail. After the operation the patient's friends should not be led to expect that an immediate change for the better will be traced in the voice, as such is never the case; indeed, a long interval of time, as well as a process of education, is necessary to acquire this result, although in many instances the improvement is very great. How far an operation in infancy tends in this direction has not yet been proved, sufficient experience in these early operations not having as yet been acquired. If a small orifice near the hard palate be left after the operation, no necessity exists to interfere again, because it is a clinical fact that they have a strong tendency to contract; and the younger the patient, the greater the probability of complete closure.

Mr. Tait believes—and I think rightly—that if the muco-periosteum of the hard palate be elevated with a raspatory from the semilune of the palate bone, the tendinous attachment of the tensor palati will be raised with it and thus paralyzed, thereby doing away with the necessity of any such division of muscles as practised by Pollock or Fergusson and diminishing the risk of the pinhole orifice at the junction of the hard and soft palates. He advocates, moreover, two or more operations—viz., the hard palate to be first closed, and the soft after some months' interval.

Fissures of the Hard Palate. These are to be treated on similar principles to those of the soft, the great point of difference consisting in the separation of the soft parts with the periosteum from the bone. For this purpose Langenbeck's instrument is the best—a kind of small hoe; with this, after making an incision down to the bone along the edge of the gum, he scrapes all the soft parts from the bone down to the free border of the fissure, the covering of the palate then hanging as a free curtain. Care is required in this proceeding not to tear or injure the soft parts, and more particularly the anterior and posterior portions where the vessels enter. The other steps of the operation are such as have been already described. Since November 22, 1873, however, Sir W. Fergusson has adopted with great success a method of dealing with fissures of the hard palate which was originally proposed by Dieffenbach in his *Operative Surgery* (1845). There is a want of evidence that the operation was ever previously performed, and Sir W. Fergusson was not aware even of the suggestion when he published his paper (*Brit. Med. Journ.*, April, 1874). The operation as seen in Figs. 226 and 227 is as follows:

Holes are first drilled with a curved brad-awl through the margins of the hard palate (Fig. 226, c) for the passage of the threads, while the palate itself is then cut through with a chisel in a line parallel to and about half an inch from the edge of the cleft (Fig. 226, B), such a step being much facilitated by acting upon Mr. Mason's suggestion of previously drilling the bone with the curved brad-awl (Fig. 226, A). This loosening of the margins of the hard palate allows the borders of the cleft to be brought together along its whole length after the margins have been pared and the stitches twisted (Fig. 227). When any difficulty is experienced in approximating the loosened portions of the hard palate, the bones may be separated and prised down by means of the chisel and the lateral openings plugged with lint. Indeed, if the bones are well loosened and the lateral openings well plugged, no sutures are required through the hard palate, the parts falling well together. The operation is very valuable, and in my hands has been successful.

Fig. 226.

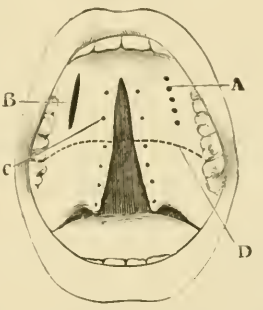
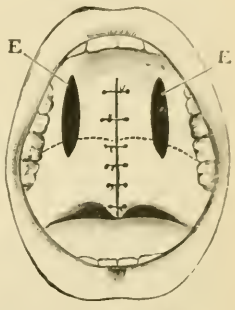


Fig. 227.



A, Preliminary punctures with awl to give line for chisel.
B, Incision through bone completed by chisel.
C, Holes bored through hard and soft palate for sutures.
D, Junction of hard and soft palate.
E, Lateral openings subsequently filled up by granulation.
(These drawings were kindly made for me by Mr. W. Rose.)

When operative relief cannot be given in these cases or has failed, the patient must be handed over to an experienced dentist; for with a good obturator of gold or other material great comfort can be given, and even a velum may be supplied of india-rubber. On these points an article in *Holmes's Surgery*, by my friend Mr. James Salter, may be consulted with advantage. Operative relief, however, is always superior to instrumental, as in the latter the patient is entirely dependent upon the mechanist.

Wounds of the palate are met with in practice from patients falling with pointed instruments in their mouths, such as pipes, sticks, spoons, etc. Small wounds need no attention and generally do well; lacerated wounds dividing the velum should be brought together by sutures; but where they have been left and a separation ensues, the edges may be subsequently pared and brought together as a fissured palate.

Perforations of the hard palate are generally due to the exfoliation of bone, and no plastic operation is of use. The proper treatment of such cases is to close the aperture by an accurately-fitting plate of metal or vulcanite attached to the teeth and arching immediately below the palate, but making no pressure upon the edges of the hole itself, as the effect of a plug is to enlarge the aperture by absorption.

Ulcerations of the Hard and Soft Palates.

These are very common as a result of syphilis, and appear as *superficial ulcerations* about the pillars of the fauces and margins of the velum. They are often preceded by an erythematous redness and take on a sloughing action in cachectic subjects. They appear, too, also as *mucous patches* at any stage of syphilis, congenital or acquired, involving at the same time the tonsils, tongue, etc. They appear as slightly elevated spots

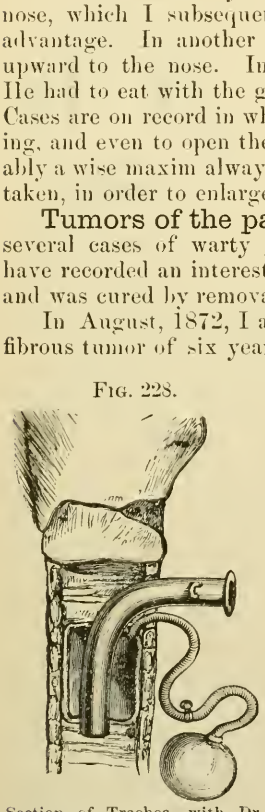
covered with ashy or yellowish membranes, beneath which some slight ulceration may be found. Frequently they are associated with other symptoms. They are to be treated as part of a constitutional disease, such local treatment being applied as the aspect of the surface may demand. Local astringents, as alum and borax, are, as a rule, of value, and also nitrate of silver or iodoform when local stimulants are needed.

Strumous Ulceration of the Palate.—This is a distressing affection, the ulcerative action being often so rapid as to destroy within a few days the whole fauces. It is chiefly met with in the young and feeble. In other instances it is slower in its action, though equally destructive, gradually eating away all the soft tissues, even to the hard palate and pharynx, and is often mistaken for syphilitic disease, or *vice versâ*. The history of the case alone can determine the point. Tonics and local stimulants are, as a rule, the only requisite treatment, good food of a liquid nutritious kind being supplied in abundance. When gargles are difficult to use, carbolic acid lotion, sulphurous acid, Condy's fluid, or iodine lotion (a drachm of the tincture to a pint of water) may be scattered over the parts with the spray-producer. In certain cases a powerful local caustic, such as nitric acid, applied with a glass brush, tends to arrest the action. As a result of ulceration of the soft palate, it sometimes happens that the palate becomes completely adherent to the posterior part of the pharynx. In one case under my observation there was only an opening the size of a crow-quill between the pharynx and the nose, which I subsequently enlarged and kept dilated by means of tents with great advantage. In another a central fissure existed, leading down to the œsophagus and upward to the nose. In this case the patient experienced great difficulty in deglutition. He had to eat with the greatest caution; otherwise, the food would pass into the larynx. Cases are on record in which it has been found necessary to enlarge this pharyngeal opening, and even to open the trachea to maintain life. Under such circumstances it is probably a wise maxim always to open the windpipe before any operative interference is undertaken, in order to enlarge the pharyngeal opening.

Tumors of the palate, cystic or solid, are occasionally met with. I have treated several cases of warty growths, simple and malignant, and in *Guy's Reports* (1869) I have recorded an interesting case of myxoma which covered the whole of the hard palate and was cured by removal.

In August, 1872, I also removed from the soft palate of a man æt. 38 a globular fibrous tumor of six years' growth, the size of an unshelled walnut, which had been for six weeks seriously interfering with deglutition and respiration. I enucleated the growth after making a free incision into its capsule, having previously been obliged to perform tracheotomy to prevent suffocation. In this case I employed Dr. Trendelenburg's tracheal tampon (Fig. 228), and found it of great value. It effectually prevented the entry of blood into the air-passages, allowed the patient to be kept under the influence of chloroform, and enabled me to complete the operation with facility and safety. (See *Med. Times and Gaz.*, May, 1872.) Where this instrument is not at hand, the fauces may be well plugged with sponge after simple tracheotomy.

FIG. 228.



Section of Trachea, with Dr. Trendelenburg's Tracheal Tampon.

The majority of cases of tumors that involve the palate spread from the gums or upper jaw.

Elongation of the uvula from inflammatory œdema is sometimes a very acute affection. It comes on rapidly at times and gives rise to suffocative symptoms. I have seen a case in which the uvula became as thick as a finger and rested on the tongue with its tip forward, and of this there is a drawing at Guy's. An incision into it, or several punctures, may give relief; but, as a rule, it is better to cut off the lower half of the organ. Elongation from congenital or other causes is far more common and is generally to be recognized by the peculiar hacking cough and husky voice to which it gives rise, the end of the uvula acting as a constant irritant to the epiglottis, or even to the glottis. There is reason, indeed, to believe that not a few of the cases of supposed laryngeal irritation are due to this cause. The removal of the lower half of the organ by means of a long pair of forceps or scissors rapidly gets rid of all the symptoms.

A polypus composed of simple mucous membrane may grow from the uvula. I have removed one from the tip, and another from the base. They give rise to symptoms identical with those of elongation. I had also a case under observation in which the

polypus had so long a pedunele as to fall at times into the orifice of the larynx and excite a violent spasmodic cough, but the man refused to have it removed.

Tonsillitis.—As an acute affection this is known as *quinsy*, and is characterized by the rapid swelling of the part, acute pain, foul tongue, and fever. Within three days, or longer, suppuration may occur; and when suffocative symptoms make their appearance, the surgeon's interference may be demanded. At times life may be sacrificed by the want of surgical attention. Some years ago a case came before my notice where a child two years of age was suffocated from the bursting of a tonsillitic abscess.

Great redness and rapid swelling of the organs are the chief local symptoms.

TREATMENT.—Fomentations externally, the inhalation of hot steam, and the administration of saline purgatives are essential points of practice. As to drugs, none seem to have so powerful an influence over the disease as guaiacum, an ounce of the mixture with some compound spirits of ammonia being the best form; and when this is employed early, suppuration rarely appears. When an abscess has formed, the sooner it is opened the better. The best mode of doing this is to cover a straight bistoury to within half an inch of its point with lint, and, having depressed the tongue with the finger, to introduce it into the swollen tissue, making a free incision, care being taken not to direct the point of the knife outward, but directly backward. Should pus appear behind the pharynx, it must be let out. Tonics, such as quinine or iron, should then be given, with good food; a speedy convalescence, as a rule, ensues.

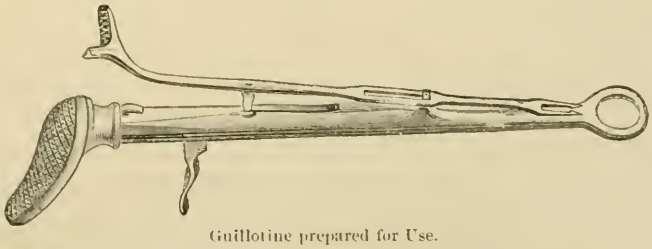
Tonsillitis Maligna.—This is a form of inflammation of the tonsils met with in feeble subjects which results in ulceration and is often most intractable. It begins as other forms of inflammation and runs its course rapidly, the ulcerating process being generally associated with sloughing. The parts about the tonsils, even the root of the tongue, often become involved. The disease is at times associated with scarlet fever or syphilis.

TREATMENT.—This affection, being always found in feeble or cachectic subjects, requires tonic treatment with both food and medicine. Good broths and milk, with stimulants, are always required; nutrient enemata should be used when enough nourishment cannot be swallowed. Quinine and iron as medicine are also called for, with small doses of laudanum to soothe pain. Locally, sulphurous acid, employed every hour or less as a spray, is very beneficial, or the local application of the mixture of iron and glycerine.

Chronic Enlargement of the Tonsils.—This is frequently met with in feeble children as well as in adults living in marshy and damp localities. It is often a sequel of the acute inflammation, but more often it appears without any such cause. There is reason, too, to believe that some of the cases of so-called chronic enlargement of the tonsils are due to new adenoid tonsillitic growths. On two occasions when removing these enlarged organs I have turned out distinct tumors the size of nuts embedded in and surrounded by tonsillitic tissue. The tumors were distinctly glandular, and under the microscope could not be distinguished from tonsil tissue. In both cases the enlargement was unilateral. Bilateral increase is probably always due to hypertrophy or chronic inflammatory enlargement.

Enlarged tonsils give rise to a peculiar nasal twang in speaking and to a most distressing snoring, the patient, as a rule, having a half-opened mouth night and day. They are

FIG. 229.



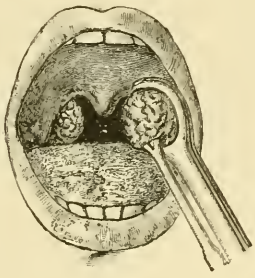
Guillotine prepared for Use.

commonly associated with irritable mucous membranes generally. I have seen them so troublesome in a child three and a half years old as to prevent the deglutition of solid food, the patient having lived for six months on liquid nourishment. Tonic treatment is essential in all these cases; so is a *simple* nutritious diet. A mixture of bark and soda at first is the best to soothe and give tone to the digestive apparatus, cod-liver oil, quinine,

and iron being subsequently prescribed. When the organs are congested from inflammation, a mixture of glycerine and tincture of the perchloride of iron in equal parts should be used. It is wise, also, to give the patient some solid iodine in a perforated box, to stand on a shelf in the day as well as in the sleeping-room; the gradual evaporation of the iodine purifies and iodizes the air in a beneficial manner.

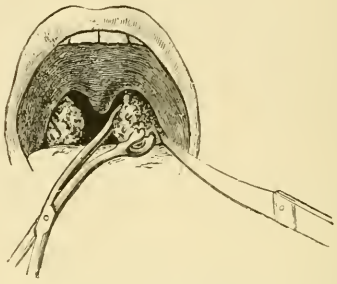
When the glands are white and hard, all hopes of curing them by medical treatment are at an end; excision is the only thing to do. For this purpose the guillotine (Fig.

Fig. 230.



Operation on Tonsil with Guillotine.

Fig. 231.



Removal of Tonsil with Knife.

229) is the best instrument to employ when it is at hand; otherwise, a pair of vulsellum forceps and a bistoury must be used, guarding the base of the latter with lint or strapping to protect the lips (Fig. 231).

Calculus in the Tonsil.

In 1860 such a case came under my care. A man æt. 38, after having suffered from enlargement of the right tonsil for a year and a half, expectorated a calculus the size of a nut, the expulsion of it having been preceded for three days by severe local pain and immediately beforehand the sensation of something having given way in the parts. When I saw him, there was a distinct cavity in the tonsil. The stone was hard and ragged, and appeared to be made up of phosphatic salts; but the patient claimed the stone, and therefore it was not examined. Small calculi the size of mustard-seeds are more common, and are supposed to be calcified tuberculous deposits. In Guy's Hosp. Mus. (Prep. 1677[50]) there is a specimen, analyzed by Dr. Babington, which consisted of phosphate of lime.

Cancer of the Tonsil.

This rapidly fatal affection happily is rare and has not received much attention. It may appear as a primary or secondary affection and in the encephaloid or fibrous form. The *former*, being the more frequent and rapid in its course, destroys life mechanically by secondary glandular enlargement, as well as by pharyngeal and laryngeal obstruction. The latter is seen mostly as an ulceration and proves fatal by exhaustion. I have in one case seen this disease cause death by sudden and violent hemorrhage owing to extension to and perforation of the internal carotid artery.

This affection begins as an ordinary enlargement of the gland, but is more rapid in its growth, and is mostly attended by early enlargement of the lymphatic glands at the angle of the jaw, and subsequently of those of the neck. When it ulcerates, the ulcer assumes the indurated jagged appearance of a cancerous sore, not unlike the deep syphilitic sore after the breaking down of a gummy tumor. It has, however, a more indurated base and border than the syphilitic. It attacks men mostly of middle age, but I have had under my care a sweep only seventeen years of age with the hard form.

Treatment.—Palliative treatment is probably the best to adopt, although Dr. Cheever of Boston has proved that the tonsil may be successfully extirpated by external incision (*Boston Med. Surg. Journ.*, 1871). Its removal from within seems almost hopeless, whether by caustics—Maisonneuve's plan—the écraseur, or enucleation. I attempted the latter in one case only with partial success, and the operation prolonged life.

Dr. Cheever performed his operation through an incision made below the angle of the jaw of three and a half inches, along the anterior border of the sterno-mastoid muscle, with a second incision extending along the lower border of the jaw. The flaps were

reflected and a large gland was enucleated. The digastric, stylo-hyoid, and stylo-glossus muscles were cut, the fibres of the superior constrictor being divided upon a director. The pharynx was opened. The finger of the operator was then swept round the diseased tonsillitic mass, which was enucleated. The hemorrhage was free, though not excessive, and twelve ligatures were applied. A steady convalescence followed. "The facility," adds Dr. Cheever, "with which the tonsil can be enucleated with the finger is surprising." This operation has been frequently repeated, and with enough success to justify its performance in cases in which the glands are not too far involved. For further information on this subject reference may be made to the article "Amygdales, No. 2," *Dictionnaire de Médecine*, 1865, and to Poland's article, *Brit. and Foreign Review*, April, 1872.

CHAPTER XIII.

DISEASES OF THE GUMS, JAWS, TEETH, PHARYNX, AND ŒSOPHAGUS.

Hypertrophy of the Gums.

Cases of this nature have been recorded by Salter, Gross, Heath, and others, and they are said to be congenital. The disease may be general or local, and for its cure nothing less than its excision, with the affected alveolus, is of any use, the gum dipping down into the sockets of the teeth in the same way as other periosteal growths are seen to do.

Polypus of the gum, or outgrowths of gum structure, are due to the irritation of carious teeth or to uncleanly habits. They can be cured by the removal of the growth and its cause.

Vascular tumors are met with on the gums, and generally between the front teeth. They are sometimes, but not always, associated with carious teeth. The outgrowth is usually small and more or less pedunculated, bleeding on the slightest manipulation. The vascular tumor occasionally presents more the features of a nævus. I have destroyed many of these growths by means of the galvanic cautery with success, but they can be removed by the knife or any caustic. When a carious tooth appears to be the cause of the disease, it should be at once removed.

A cancerous disease of the gums puts on precisely similar appearances to those seen in similar diseases of the fauces, face, or tongue—an irregular, excavated, ulcerating surface discharging fetid pus, associated with pain and glandular enlargement. Most of the cases of cancerous epulis are epithelial. The benign form of epulis is generally an affection of young life, and the cancerous of the old and middle-aged.

Inflammation and ulceration of the gums is met with in children, the result of stomatitis, and in adults from other causes. It always occurs in cachectic subjects and must be treated generally.

Abscesses about the gums are very common and are frequently the result of disease of the teeth. Dentists tell us, however, that these "gum-boils" rarely induce any disease of the bone, though they sometimes arise from it. When connected with a carious tooth and of long standing, nothing but the removal of the tooth will effect a cure. A free incision, however, into the inflamed gum generally gives relief, cuts short the disease, and may save a tooth; it may, moreover, prevent burrowing and much further trouble. When associated with disease, such as "necrosis," or death of the bone, the removal of the dead portion is an absolute necessity.

Necrosis of the Jaws.

Necrosis may take place as a result of ostitis or periostitis or it may follow a fracture. It is well known to follow an exanthem and to be brought about by the fumes of phosphorus or of mercury. It is found in both upper and lower jaws. An analysis of 50 consecutive cases shows that 19 were in the upper, 29 in the lower, and 2 in both, thus controverting the assertion of Stanley, which has been repeated by others, that necrosis of the upper jaw is rare. It may show itself at any period of life. I have seen it in an infant a fortnight old, although it is more common in the young and middle-aged than in

the aged. It may attack any portion of the bones, and even the condyloid processes of the lower jaw may die and be removed, leaving a movable jaw by the spontaneous formation of a new joint. The child, æt. 8, from whom I removed the bone illustrated below (Fig. 232), could move the jaw as well as if the condyle had never been destroyed, and in *Guy's Hosp. Rep.* for 1869 I recorded another similar case. After necrosis of the upper jaw there is little or no osseous repair to be expected; in the lower jaw it may be very complete.

FIG. 232.

Portion of Lower Jaw removed for Necrosis from a Child æt. 8, the Movements of the Jaw subsequently being perfectly Regained.

Necrosis of a bone is always preceded by symptoms of inflammation, such as swelling and pain, followed rapidly by suppuration and the formation of sinuses leading down to the bone, which may be felt by a probe. A single sinus below the jaw or in the neighborhood may be due to the presence of a diseased tooth.

Necrosis is likewise a common affection as the consequence of some fever or exanthem, and this fact is now fairly recognized. It is more common in children than in adults. As a rule, it appears on the decline of the fever, with pain and swelling about some portion of the gums, and rapidly passes on to suppuration and death of the bone. The necrosis, however, is generally confined to the alveolus; in exceptional instances only it involves the body of the bone. Both jaws are equally liable to the affection. In the *Guy's Hosp. Reports* for 1869 I recorded a series of cases to illustrate these points. In one case, narrated in detail—that of a woman æt. 25 who in infancy had lost a large portion of her upper jaw after measles—the lower jaw had grown up to fill in the deficiency in the upper. It was nearly one inch higher in its vertical measurement on the right side than the left; it seemed, indeed, as if the lower jaw had grown upward for want of the regulating influence of the natural pressure which the teeth of the upper jaw must exert upon those of the lower when in contact with them. I have recently seen a similar case where the increase of growth had taken place in the upper jaw, in consequence of a deficiency in the lower.

Necrosis of the jaws as a result of the phosphorus poison is now rarely seen, in consequence of the common phosphorus being less frequently employed than formerly in the making of lucifer matches. Dr. Bristowe in his report to the Privy Council in 1863 clearly showed that it is to its influence the disease is to be attributed, *the amorphous phosphorus* being harmless. The first notice of the affection in this country was by my colleague, Dr. Wilks, in the *Guy's Hosp. Rep.*, 1847, page 163. The disease is acute in every sense. It may involve a part only or the whole of the upper or lower jaw, both seeming to be equally liable to the affection; but in the majority of cases the teeth of the affected bone are more or less diseased or deficient. It is a rare thing to find the disease in subjects who have sound teeth or in those who have a complete set. Some openings down to the bone, either through carious or deficient teeth, appear to be necessary to enable the phosphorus fumes to act upon the bone. Dr. J. Wood of New York records a case in which the whole bone died and was restored. The disease begins for the most part by a general aching of the teeth, followed by rapid suppuration and necrosis of the affected bone. The constitutional are usually as severe as the local symptoms.

TREATMENT.—When dead bone can be detected in either the upper or the lower jaw, its removal is the only one form of practice which ought to be entertained; and this should be effected by the mouth with as little disturbance as possible to the soft parts or to the new bone-forming tissues, such as the periosteum. When external incisions are necessary, they should be made where afterward they will be little seen.

In necrosis of the *upper jaw* the bone can nearly always be removed by means of incisions made *beneath* the cheek. An incision *through* the cheek never seems necessary. In necrosis of the *lower* jaw, when incisions through the integument are demanded, they should be made below the lower border of the bone. When the dead bone is fixed, or rather before it has been thrown off from its attachments and before a new casing of bone has been formed, all operative interference must be condemned, particularly in the lower jaw, as there seems little room to doubt that the muscles, acting upon the new bone before it has become consolidated, may alter its shape and produce deformity. Under these circumstances, the surgeon should content himself with seeing that all pent-up pus has free exit by means of incisions through the gum, also that the patient's mouth is kept as clean as possible by frequent washing, and that his general condition is maintained by means

of tonic medicine and nutritious diet. When the necrosis is confined to the alveolus in which the temporary teeth are situated, great care should be taken that the parts beneath are not disturbed and that the permanent teeth are not interfered with. Even when exposed, these permanent teeth need not of necessity be removed. In young patients where much loss of bone has taken place it seems desirable to have some artificial substitute, in order to prevent the occurrence of such an overgrowth of the opposing jaw as took place in the cases already referred to. Where the antrum is exposed by exfoliation, much may be done by the dentist to fill in the gap. At times, also, the fistulous opening takes place externally; thus, in 1864, I was called on to treat a woman æt. 34 who nine years previously had had extensive necrosis of the upper jaw, and, as a consequence, a fistulous opening the size of a sixpence was left below the right eye, communicating directly with the antrum. The soft parts were firmly connected with its margins and the lower lid was drawn down. I raised the integument from the bone by making free subcutaneous incisions, pared the edges of the flaps, and brought them together over the opening in the bone. Good union followed, and the deformity was removed.

Epulis.

Under this term "epulis" are included, rightly or wrongly, most of the tumors of the gums, polypoid or diffused, simple outgrowths from the gums due to the irritation of a carious tooth or stump, papillary, fibrous, fibroplastic, myeloid, epithelial, and cancerous tumors.

The true or fibrous, fibroplastic, and myeloid epulis (for these elements enter in different proportions into all the benign forms of epulis) are diseases chiefly of the periosteum

Fig. 233.

Fibrous Epulis from Gum.
(Drawing, Guy's Hosp. Mus., 1715. Mr. Birkett's case.)

Fig. 234.

Epulis springing from Bone.
(Mr. Key's case.)

(Fig. 233) and are rarely cured without removal, together with the portion of bone upon which they are placed, since the growth dips down into the sockets of the teeth about which it springs. At times, however, they invade the bone itself (Fig. 234), the endosteal membrane which lines the bone being continuous with the periosteal covering it. They appear as simple fleshy outgrowths of the gum about a tooth and develop into a large mass of a firm or semi-elastic tissue. At a later stage this mass may ulcerate and break down.

In exceptional cases a tumor that appears to be an epulis results from the abnormal development of a tooth; this was the case in a boy æt. 11, from which Fig. 235 was

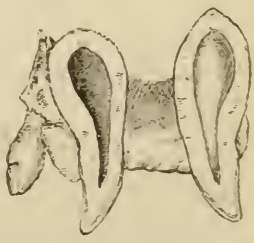
Fig. 235.

Front view of Tumor of Alveolus. (Due to hypertrophy and dilatation of tooth fang.)

Fig. 236.

Odontone after Removal.

Fig. 237.



Section of Odontone, showing expanded thickened Foot of Incisor Tooth.

taken, the expansion of the alveolus having been brought about by the development of an odontone of the root fang of an upper incisor tooth which had been growing for three or four years.

Fig. 235 illustrates the swelling of the gum before the removal of the disease, Fig. 236 the tumor on its removal, and Fig. 237 the same in section. My friends Messrs. Salter and Moon informed me that this is a unique case. In the diagnosis of such a case the protrusion of the crown of the tooth becomes a valuable guide.

Treatment.—The removal of the disease of the teeth or stumps that are involved in it, as well as of the bones with which it is connected, is the only sound practice to adopt. A good pair of cutting pliers which will nip off as much of the alveolar process as seems involved is the best instrument to use, a small hand-saw having marked out vertically the limit of the incision. When the bone is not removed, a return of the disease is almost certain.

Tumors of the Jaws.

Some of the most remarkable tumors of these bones are due to hypertrophy or hyperostosis, the lower jaw, with other bones of the face and head, being generally involved. Mr. Howship's well-known case of disease of the upper jaw, which is noticed everywhere, is a case in point; so is that of Mr. Bickersteth, which was exhibited at the Pathological Society in 1866, and which he described with all minuteness in the *Transactions* of the year. The disease is usually symmetrical, showing itself as a uniform enlargement of the bones involved, the upper jaws projecting as two large globular masses. When the ascending ramus of the lower jaw becomes hypertrophied and elongated, a curious one-sided deformity of the face exists.

Cystic Disease of the Antrum.—This is a special affection and often connected with irregular dentition, though how often has not yet been determined.

Suppuration of the cavity is often due, doubtless, to an extension of inflammation from the teeth, and may arise from a blow or other cause. It is known by severe local pain extending over the face and forehead, local swelling, and extreme tenderness, the constitutional symptoms being often very severe. When pus has formed, there may be rigors; and the abscess may burst either into the nose or into the mouth beneath the cheek, the antrum, under these circumstances, becoming much distended. In rare cases it may make its way through the cheek, and in one where this occurred an opening into the antrum the size of a fourpenny piece was found on making an incision down in the bone beneath the cheek. In neglected instances the floor of the orbit may be displaced and vision interfered with, or even destroyed. (*Vide* Salter, *Med.-Chir. Trans.*, 1863.)

Treatment.—When suppuration has been made out, the antrum should be opened; and if its anterior wall be expanded, an opening may also be made into it without fear at the most projecting point with a trocar or other sharp instrument. The relief given by these means is very signal. In one case of a lady that came under my care some years ago it was instantaneous and permanent. When diseased teeth are present in the bone, they should all be tested by a sharp blow and the most tender removed. A jet of ether spray on each tooth will prove an admirable test, the cold searching out the slightest disease. It is never advisable to remove sound teeth unless some evidence exists of their alveoli being diseased. In all these cases the cavity must be kept clean by syringing. A chronic abscess in the antrum may be so insidious in its formation as to induce the surgeon to believe that a tumor exists. Liston gives an instance in his *Practical Surgery* of such an error, in which removal of the jaw was attempted. In all tumors of the upper jaw the probability of the presence of a large cyst should never be forgotten.

Hydrops Antri.—Under this term is grouped a number of cases which include examples of cysts of the antrum, cysts of its wall, and cysts placed outside the bone, and all are characterized by a gradual, painless expansion of the part which rarely produces other symptoms than those due to mechanical pressure. The swelling may encroach on the nose, and cause obstruction; on the orbit, and press on the globe: on the mouth, and produce bulging of the palate: and on the cheek, so as to cause deformity; indeed, it is often because of this that the patient is induced to seek advice. When the expansion is great, the shell of bone may become so thin as to crackle like parchment under pressure or to appear as if only membranes. M. Giraldès in 1853 (Montyon prize) was the first to describe these cysts with clearness, although Mr. W. Adams had previously recognized them. (See *St. Thomas's Hospital Museum Catalogue*.) The old surgeons looked upon this affection as the result of obstruction to the aperture between the nostril and antrum, the dilatation of the bone being due to retained mucus; but this is now known to be an error. Giraldès regards these cysts as dilatations of the glandular follicles of the mucous membrane. The fluid contents of these cysts are always viscid, occasionally clear, but mostly blood-stained, sometimes purulent, containing cholesterine, but

never pure mucus. In 1878 I had a case in a boy æt. 16, with the late Mr. R. Phillips of Leinster Square, where the fluid was serous and blood-stained in a high degree.

The *lower jaw* may likewise be the seat of a simple cystic tumor or expansion. In 1875 I had a case in a woman æt. 42 in whom the cyst had expanded the ascending as well as part of the horizontal ramus, and it contained no growth. The preparation is in the Guy's Museum (1091[2]).

Dentigerous cysts are clinically closely allied to those just described; pathologically they may differ; but there can be no doubt that the cysts are connected with the teeth, which are in some cases fully developed and in others imperfectly so. They are found in both upper and lower jaws. Heath, in his excellent *Essay on the Jaws* (3d edit., 1884), informs us that cysts of small size in connection with the fangs of permanent teeth are frequently found on extracting the latter, but give rise to no symptoms demanding surgical interference. Occasionally growing to a large size, they produce absorption of the containing alveolus and give rise to a prominent swelling. The disease is generally slow in its progress and tolerably painless; by its pressure the cyst may cause absorption of the bone with which it is in contact and lead to a deep excavation. Paget relates in his *Surgical Pathology* such a case as a cyst near the gums, and I have had under observation a woman who had a tumor in her left cheek for years, which when opened discharged some watery fluid. She applied to me for a bony projection of the cheek that was clearly the edge of the alveolar process of the upper jaw, the bone above having become absorbed by the pressure of the cyst, thus causing a cup-like depression. She had had all her teeth removed at different times by dentists, under the impression that the disease was due to them.

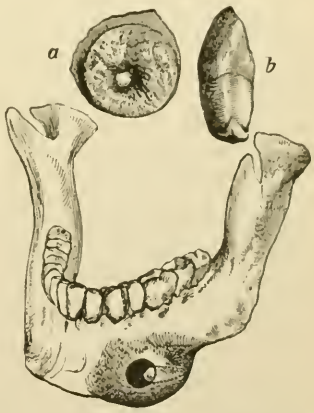
The *dentigerous cysts* are found in both jaws, and are almost always connected with the permanent teeth, rare cases being recorded in which the temporary were implicated. In this affection the teeth fail in development and remain within the jaw; the tooth acts as a foreign body, sets up irritation, and causes the cystic affection I am now considering, or some solid growth. Thus, in a boy æt. 6 who came under my care some years ago a cystic enlargement of the jaw of three years' development existed. It encroached on the orbit, mouth, and cheek. I made a free opening into the anterior wall of the cyst, in the bone, and through this an incisor tooth was seen with its crown upward (Fig. 238). The tooth was removed, and a good recovery ensued. In January, 1872, I treated a similar case in a girl æt. 17, sent to me by Mr. Salter, who had her under observation for two years. The disease was in the right upper jaw, and the right canine tooth was deficient. I exposed the cavity and removed the tooth (which was growing in an abnormal direction upward and inward), a good recovery taking place. On July 24, 1875, I trephined a tumor of the lower jaw, of three or four years' growth, of Miss R——, æt. 30, a patient of Mr. R. Moon of Norwood and also of Mr. Salter, and removed from it a canine tooth which was resting obliquely in the cavity (Fig. 239). Mr. Salter has collected many similar cases. It is well to remember that these dentigerous cysts, like other cysts of the jaws, may simulate solid tumors. When they occur in the lower jaw and expand the bone, this error is very likely to take place. Thus, in 1881 a gentleman æt. 58 came to me with an enlargement of the left horizontal ramus of his lower jaw which had been coming on for years, and with this there has a little discharge from his gums. I explored this and struck a tooth, which Mr. Moore skilfully removed. It was a molar tooth, which was lying horizontally in the bone with its crown forward and its fangs grasping those of the last molar. In all tumors of the jaws that have a smooth or cystic outline it is well

FIG. 238.

Tooth as seen through Opening in Upper Jaw.

Natural Size of Tooth when Removed.

FIG. 239.



Canine Tooth as seen in Case of Miss R——, in expanded Lower Jaw, with Tooth (*b*) of its Natural Size. *a*, bone removed by the trephine.

to make an exploratory puncture for the purpose of diagnosis. When the walls crackle from the thinness of the expanded cavity, the diagnosis is simple.

TREATMENT.—The free opening of the cyst, with the extraction of any tooth that may be present in it, is the one essential point of practice to observe in all these cystic diseases of the jaws, upper or lower. This can be done with a knife or a sharp pair of forceps after a perforating wound has been made by a trephine, drill, gouge, or pointed instrument. To induce suppuration of the cyst, it is a good practice to plug the cavity with lint. When the cavity is large, it is wise to take away a considerable portion of its wall. Removal of a segment of bone for cystic disease is rarely needed. Before, however, the pathology was understood, this malpractice was often perpetrated, as our different museums too truly testify.

Dentigerous tumors may likewise occur. In Fig. 240 is illustrated a case in which I removed the upper jaw of a child æt. 8 for a nearly solid myeloid tumor of the jaw clearly originating in a malplaced tooth which was growing from the posterior part of the orbital plate of the bone; one or two cysts existed in the growth enough to allow of its being called cystic. There was no possibility of making a diagnosis in this instance; such examples are very rare.

FIG. 240.

Dentigerous Tumor of Jaw.

Tumors of the Jaws.—These are of different kinds, simple and malignant, connected and unconnected with teeth. When in the antrum, their dental origin should be suspected; but in both upper and lower jaws solid tumors of all kinds have been found with teeth as their centres.

Polypi of the antrum—as are those of the nose—are occasionally met with, and they show themselves mostly as projections into and through the nostril, the tumor making its way through the nasal wall of the antrum, and at the same time generally expanding its facial wall. I have seen four well-marked cases of this sort, and in two the whole mass was removed through the nostril, which was laid open and turned back. In the third the cheek was reflected outward at the same time and a large opening made into the antrum, allowing the surgeon to scoop out the growth. Two of these cases occurred in the practice of Mr. Cock, and two in my own. The constant flow from the nostril of the affected side of a quantity of clear fluid is a valuable symptom of these growths, as shown by Paget's case (*Clin. Soc. Trans.*, 1879).

Tumors of the Upper Jaw.—Weber, quoted by Heath, informs us that in an analysis of 307 cases of tumors of the upper jaw, more than one-third of the whole number may be set down as sarcomatous simple tumors, one-third as osseous, and less than one-third cancerous, the myeloid being included in the first of these groups. They may grow also from any part of the bone or periosteum. When they originate in the

FIG. 241.

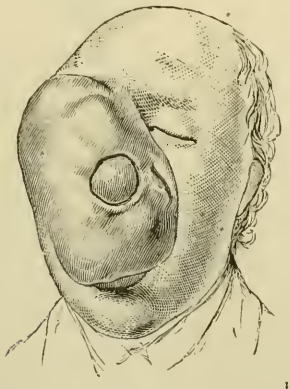


FIG. 242.

Enchondroma of Upper Jaw.

Before operation. (Model, Guy's Hosp. Mus., $3^{8}{}^{10}$.) After death. (Model, Guy's Hosp. Mus., $3^{8}{}^{12}$.)

antrum, they expand its cavity, as is the case in the cystic disease, and cause a bulging of one or more of its walls. When they spring from a surface or plate, the tumor will project from it, leaving the other surfaces unaffected. The fibrous, in all its forms, and the osseous are usually of slow growth. They are often painless, and trouble only from

their size. The sarcomatous, myeloid, and cancerous are of more rapid growth. The fibrous or sarcomatous are usually periosteal growths; the osseous and myeloid, endosteal. The cancerous may belong to both. The cartilaginous are very variable in their progress—now very slow, and then rapid. They are chiefly of the mixed kind, fibre tissue largely predominating in tumors of slow formation. They frequently involve many bones. Sir J. Paget (*Surgical Path.*) states that in the only case on record of enchondroma of the upper jaw alone the disease was removed by Mr. Morgan, late of Guy's, from a man æt. 24; the tumor was of the right maxilla and was of nine years' growth. The patient survived the operation seven years. Figs. 241 and 242 illustrate the case, the first being taken before Mr. Morgan's operation and the second after the patient's death. Dr. Heyfelder of Munich says, however, that he found 8 such cases out of 150 of disease of the upper jaw.

Treatment.—All solid tumors of the upper jaw must be extirpated, but not more of the bone should be removed than is necessary. Sir W. Fergusson established this rule in practice, and it is one that all surgeons should strive to follow. Thus, when the disease springs and projects from the facial surface of the bone, the tumor, with the facial plate alone, requires excision. When the alveolar process is alone implicated, the other portions of the bone must not be touched. Where possible, the palate plate should be preserved; and it is bad surgery to interfere with the orbital plate without an absolute necessity. When the whole bone is involved in the disease, it must be removed; but such cases are exceptional. In many cases where the disease originates in the antrum a partial removal of the bone will suffice, if the surgeon can at first only lay open the cavity and find out the base of the growth. For perforating the antrum with a view to exploration Sir W. Fergusson recommends an ordinary carpenter's gimlet.

Operation for the Removal of Part or the Whole of the Upper Jaw.—The incision now almost universally adopted for the removal of tumors from the upper jaw is the one of Sir W. Fergusson (Fig. 243), as by it all the necessary room is given to remove even the largest growth. The facial nerve and artery are divided where by their size they are of small consequence and the scars are so placed as to become almost imperceptible. In tumors of *moderate* size the incision should be carried through the median line of the lip into the nostril, when, by raising the nostril and retracting the cheek outward, abundant room is obtained. When more room is required, the operator may extend his incision round the ala and up the side of the nose toward the inner canthus; and if this is still insufficient, a third incision may be made, from the termination of the second along the lower border of the orbit.

Fig. 243.

Fergusson's Incision for Removal of Upper Jaw.

Fig. 244.

The dotted line, *a*, Gensoul's Incision; *b*, Lizar's and Liston's.

These incisions are indicated in Fig. 243, which was taken from a man æt. 35 from whom I removed an osteo-chondroma, of twelve years' duration, involving the facial and palate plates of the superior maxilla. The dark line indicates the incision made; the dotted extra line, that which may be required in exceptional instances. Fig. 244 illustrates Gensoul's and Liston's method.

In some cases the ala of the nose alone may be turned up. I removed a fibrous tumor growing from the nasal process of the superior maxilla by this incision, and found ample room. The incision having been made and the integument reflected sufficiently to expose the tumor, all bleeding should be stopped by ligature or torsion. Assuming that the whole bone has to be removed, the incisor tooth of the affected side must be extracted and the palate plate of the upper jaw with the alveolus divided with a fine saw (Fig. 245) introduced into the nostril. The malar process

Fig. 245.

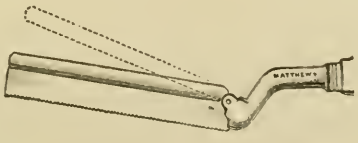


Fig. 246.

Lion Forceps.

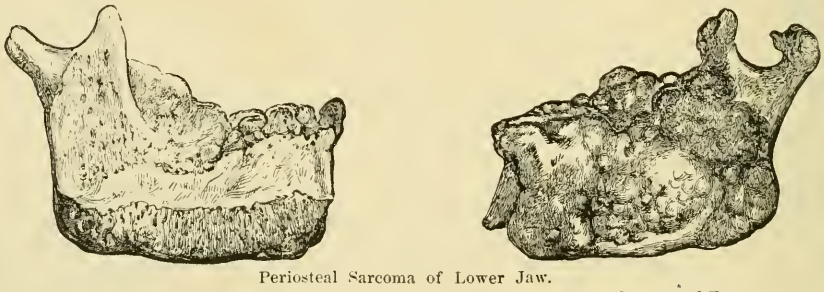
of the maxillary bone is then to be partially sawn through, as well as the nasal process of the superior maxilla, their complete section being made with bone forceps. The tumor should then be seized with the Lion forceps (Fig. 246) and the whole wrenched off, bone

forceps and scissors being employed to complete any section that may be required. The infraorbital nerve should be divided with scissors and the soft palate left as little injured as possible. If any portions of the disease remain, they can now be removed. All bleeding vessels are to be treated by ligature, torsion, actual cautery, or styptics, and the parts carefully brought together with interrupted sutures.

When the disease, says Heath, is of less amount and the orbital plate not involved, this should be preserved by carrying a saw horizontally *below* it; and if the palate be not involved, this may be advantageously kept intact by making a similar cut immediately *above* it. Sir. W. Fergusson advises that the disease should be cleared out from the centre toward the circumference, so as not to remove healthy structures unnecessarily; and this may be readily accomplished by means of the many forms of curved bone forceps with which surgeons are now familiar, aided by the gouge.

In a case of myeloid disease of the upper jaw involving the whole of the hard palate I peeled off all the soft parts from the bone, beginning at the alveolus, and, having removed the diseased bone, brought them up again in position and fixed them to the mucous membrane of the cheek where it had been separated from the bone. By this means I preserved the roof of the mouth from the first, and, what is more, eventually obtained an excellent new palate. The practice, particularly in young subjects, is probably worth following.

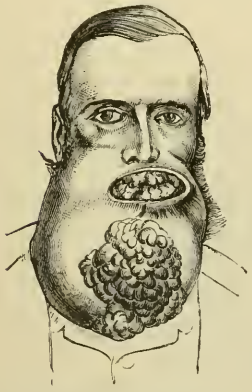
FIG. 247.



Periosteal Sarcoma of Lower Jaw.
View of section. External aspect of Tumor.

Tumors of the lower jaw grow to enormous dimensions, and pathologically are very similar to those of the upper. The fibrous in one of its forms is probably the most common, the periosteal tumor being more frequent than the endosteal. The latter may occupy the dental canal, as illustrated by a case of Mr. Cock's (Guy's Hosp. Mus., 1091[25]) in which the dental nerve passed through the tumor. The periosteal growth is often an épulis, and a good example of this form is represented in Fig. 232. But a more typical example of a true periosteal sarcoma, which I removed in 1872 from a girl æt. 20,

FIG. 248.



Fibro-Cellular Tumor of the Lower Jaw. (Mr. Heath's case.)

FIG. 249.

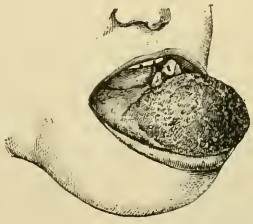


FIG. 250.

Fibro-Cystic Disease of Lower Jaw.
Guy's Hosp. Mus., Drawing 457. (Key's case. During life.)
Guy's Hosp. Mus., 109050. (Key's case. Tumor after removal.)

is illustrated in Fig. 247. The tumor was of three months' growth. It returned three months after removal and destroyed life by suffocation, having grown to the size of the patient's head. Microscopically, the tumor was a spindle-celled periosteal sarcoma. One of the largest fibro-cellular tumors of the bone on record occurred in Mr. Heath's practice, and is illustrated, with his permission, in Fig. 248. It was removed from a man æt. 32, and the disease was of eleven years' growth; it weighed 4 pounds 6 ounces. The man died from exhaustion on the sixth day.

Fibro-cystic tumors of the lower jaw are very common and have the same clinical history and aspect as the cystic tumors to which attention has been already directed. The most beautiful example on record is that which was removed by the late Dr. Hutton of the Richmond Hospital, Dublin, and is illustrated in Heath's book; it was made up of cysts of nine years' growth and in a young woman only 20. A yet more remarkable case was operated upon by Mr. Key in 1811 in a boy æt. 13 (Figs. 249, 250). The tumor was of two years' growth and painless. Mr. Key removed the whole by sawing through the lower jaw just below the angle on each side, and a good recovery ensued. Mr. Eve in his excellent lectures at the College of Surgeons in 1882 strove to show that these cystic tumors of the lower jaw are in their origin examples of epithelioma.

Cartilaginous growths are uncommon and occur in early life, and, as already stated, are periosteal and endosteal. A fine example of the latter can be seen in Prep. 1091[15], and 1091[16], Guy's Hosp. Mus., which Mr. Key removed in 1846 from a woman æt. 29 in whom the disease had been coming on for nine years. In the preparation the fibro-cartilaginous substance is seen to be placed between the plates of bone of the jaw, the teeth being in the middle of the new growth. The periosteal tumor grows to a large size.

Osseous tumors are sometimes the result of ossified enchondroma. There is in St. Thomas's Museum a specimen of this kind which was removed by Mr. Cline. Bone may, however, occur as an independent growth in the form of cancellated or ivory exostosis, which may sometimes grow to a large size. Other troubles may spring from such a growth; for example, in March, 1877, I had to remove a portion of the lower jaw from a lady æt. 50 who had had an exostosis growing for twenty years from its inner surface at a point corresponding to the right bicuspid and canine teeth. The growth had not given rise to any trouble till the soft parts covering its apex had begun to ulcerate, when, from its roughened surface, the bone so irritated the floor of the mouth as to set up ulceration which was thought to be cancerous. I removed the exostosis with the bone, and then reached the supposed cancer, which I isolated by needles passed through the base of the growth and removed by means of the galvanic écraseur. A good result followed, and the lady is now well.

Sarcomatous tumors are met with in great variety, the softer kinds being recurrent and clinically malignant. Some of the very vascular pulsate.

Cancerous tumors are mostly periosteal and invade the bone by extension. They are of the epithelial form when attacking the gums and mucous membrane, and of the tubular variety in the nose and antrum when originating where the epithelium is columnar.

Treatment.—Tumors of the lower jaw, as of the upper, are to be treated by excision, and the operation, though large, is most successful. I have on more than thirty occasions removed large portions of the jaws with but one death, and that was from inflammation of the lungs. Heath says that Mr. Cusack removed large portions in seven cases with only one fatal result, and Dupuytren operated in twenty with only one death. The success of Sir W. Fergusson, Syme, and Liston is well known.

Small tumors of the jaw, and particularly of the alveolus, may with good cutting forceps be removed from the mouth. If more room be required, an incision may be made outward or downward at the angle of the mouth. On many occasions I have obtained all the room I required by making a horizontal incision below the level of the jaw and a dissection of the soft parts off the bone.

Mr. Maunder has shown that large portions of the lower jaw the seat of tumor may be taken away without external incision after detaching periosteum by means of the raspatory.

When a large tumor has to be removed, it may readily be exposed by a curved incision carried along the posterior surface of the tumor from above the angle of the jaw to the median line, turning the soft parts up. In doing this the facial artery will be divided, when the two ends should be at once secured by torsion. The knife, says Fergusson, should be so lightly carried over the artery that the vessels need not be divided till the flap is being raised. In this way blood is saved. The labial margin of the lip rarely need be divided. The tumor having been exposed, its surface must be well examined, with the view to the removal of the growth by cutting away the external plate of bone which covers it in, by means of the gouge and bone forceps. This step is wise in doubtful cases, as a large number of tumors of the jaw, particularly the cystic, may be scooped out, and recovery will ensue. If the tumor and jaw require excision, a tooth must be extracted in front where the bone is to be divided and a small saw applied, after which the bone should be grasped with the Lion forceps and drawn outward, the surgeon subsequently carefully dividing all the soft parts that hold it in position on its inner surface

and keeping the knife *close to the bone*. When the disease stops at the angle, the saw and forceps are again to be applied and the tumor removed. Where disarticulation is required on account of the extension of the disease, the jaw must be forcibly depressed, so as to bring the coronoid process within reach and allow of the division of the insertion of the temporal muscle. The condyle may then be twisted out, the knife dividing cautiously the insertion of the external pterygoid and such ligamentous fibres as are put on the stretch. Fergusson says that in doing this he found that the condyle actually separated from the periosteum on its inner side, thus facilitating its removal; and in two cases of my own I found this to occur—in one after the division of the periosteum with the knife. When the tumor is so large as to be wedged in and to prevent this mode of dislocation, the best plan is to reapply the saw and cut off the tumor as high as may be, and subsequently to remove the remaining portion of jaw.

When the central portion of the lower jaw is removed, there is danger of the tongue falling back and causing suffocation; to prevent this a ligature may be passed through the tip of the tongue and held during the operation, and on the completion of the operation fastened to the wound. The ligature should be removed on the second or third day.

After the operation all arterial bleeding should be stopped and any oozing arrested by the application of a sponge wrung out of hot iodine water; the edges of the wound should be brought together by interrupted sutures. Convalescence is generally rapid and recovery complete. The deformity that follows the operation is in most cases so slight as not to be observed; the interval left by removal of bone is filled with dense fibre tissue. Bone is never reproduced, but the tissues soon become firm enough to bear the support of artificial teeth.

The half-sitting position is probably the best in all these operations on the jaws, and chloroform may be given without fear.

For more details connected with this subject the student may refer to Heath's admirable *Monograph on the Jaws;* Fergusson's *Surgery;* Liston's paper, *Med.-Chir. Trans.*, vol. xx., and his *Pract. Surgery.*

Disease of the temporo-maxillary articulation is rarely met with—more rarely, indeed, than disease of any joint in the body. Of the few examples of it I have seen, one was in a woman æt. 34 who had had it for nine years, suppuration having existed for six; several sinuses led down to the joint and the jaw was nearly fixed; dead bone appeared to be present, but the patient refused to have any surgical interference. Another case was a girl æt. 18 in whom both sides of the lower jaw were completely anchylosed. In Guy's Hosp. Museum there is also a splendid specimen (No. 1070) of complete synostosis of the articulation.

The cases already quoted of necrosis of the condyloid process of the lower jaw and recovery with a sound joint may here be referred to.

Closure of the jaws may be caused by some spasmodic condition of the muscles of the jaw secondary to disease of the teeth or to the cutting of the wisdom teeth. In the latter case the mouth must be forced open, under chloroform, by means of the screw gag or wedges, and the tooth removed, or, what is better, room made for it to come forward by the extraction of a neighboring molar. It may likewise be caused by anchylosis or by the contraction of cicatrices, either within or without the mouth. In February, 1878, I operated upon a woman æt. 43 who for thirty-seven years had had her jaws locked from adhesions between the cheeks and gums which had compelled her to live on liquid food for the whole of this period. I divided the cicatrices and opened the jaws with a promise of a good recovery. Two years later she could take and masticate food. The condition had followed scarlet fever. Dr. S. Gross, in his *System of Surgery*, informs us that ulcerative causes are the most common, and he attributes the majority to the evil practice of giving calomel to salivation. In rarer cases the immobility is occasioned by an osseous bridge extending from the lower jaw to the temporal bone, this condition being generally associated with chronic articular arthritis. "However induced," writes Gross, "the effect is not only inconvenient, seriously interfering with mastication and articulation, but it is often followed, especially if it occur early in life, by a stunted development of the jaw, exhibiting itself in marked shortening of the chin and in an oblique direction of the front teeth."

TREATMENT.—Where the cause is in the joint, and cannot, as can dead bone, be removed, the surgeon may attempt to break up the adhesions by forcibly opening the mouth under chloroform, or he may divide the bone below the joint. When due to cicatrices and nodular plastic matter, little good has ever been derived from their division, although in the case previously alluded to the result was satisfactory. Esmarch of Kiel,

in a paper *On the Treatment of Closure of the Jaws from Cicatrices*, 1860, has, however, described an operation which the Messrs. Henry, C. Heath, MacCormac, Mason, Lawson, and Annandale in this country have practised with success enough to indicate its value.

Operation.—This consists of the removal of a piece of the lower jaw for the formation of a new joint, and is to be carried out by making an incision along the lower border of the jaw in front of the masseter, raising the integument, and removing with a hand- or chain-saw a wedge of bone measuring about an inch above and a half inch below. Where only one side of the jaw is affected, it is, without doubt, the best operation that can be performed, the patients recovering their masticatory power in two or three weeks. It must be mentioned that about the year 1860, Rizzoli of Bologna performed a somewhat similar operation to Esmarch's, dividing the jaw, but not removing any portion of it.

Deformities of the jaws are sometimes seen as a consequence of some disease of the tongue, such as hypertrophy, the mechanical pressure of tumors during growth, the evil influence of cicatrices, more particularly about the neck and mouth, and of various other causes. For these surgery may often do much; but when this fails, the dentist can often give relief. I have seen the upper jaw in at least six cases of torticollis nearly one inch less in its vertical diameter than the opposite bone, and I have already alluded to a case where the lower jaw was nearly an inch higher than natural, to make up for a deficiency in the teeth of the upper jaw which had existed from childhood.

Dislocation of the Jaw.

This may involve one or both condyles, two out of every three cases being bilateral. It may be caused by direct violence on the jaw, but more frequently by yawning. Sir A. Cooper tells of a case in a child where it was produced by the forcible introduction of an apple into the mouth, and dentists know of its being produced even by the extraction of a tooth.

Fig. 251.

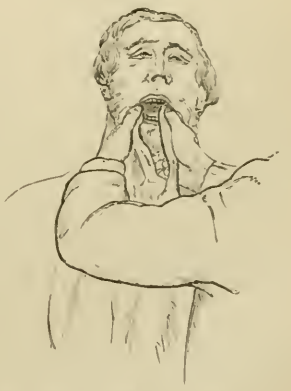
Dislocation of the Lower Jaw. (Couper's case, *London Hosp. Rep.*, 1864.)

In the **double** dislocation the mouth is widely open, the jaw is fixed and projecting, the lips are separated, and, as a consequence, speech is very difficult. Deglutition is much interfered with, and the saliva flows from the open mouth. In front of the ear a marked hollow will be perceptible, and *above* the zygoma, in the temporal fossa, an undue prominence (Fig. 251). Adams of Dublin (*Dub. Quart. Journ. Med. Science*, vol. i.) first noticed these symptoms, and Dr. R. W. Smith (*Fractures*, 1854) believes them to be caused by the "displacement and stretching of the fibres of the temporal muscle on the upper surface of the condyle."

In the **single** dislocation the chin is oblique, but usually directed toward the *sound* instead of toward the *injured* side, as in fracture of the neck of the bone. In exceptional cases, however, this is not to be observed. The other symptoms are similar to those of double dislocation, the hollow in front of the ear being the most characteristic.

Congenital dislocations have been described by Smith, Guérin, Langenbeck, and Canton. Sir A. Cooper has also drawn attention to *subluxation*, in which he assumed that the condyle of the jaw slipped in front of the interarticular fibro-cartilage. It is caused and characterized by the same conditions as those of dislocation, and it is probably a partial dislocation forward.

Fig. 252.



Reduction of Dislocation of Lower Jaw.

Treatment.—Partial dislocations or those described as subluxations are usually reduced by the patients themselves by some lateral movement of the jaw or by gentle pressure upon the chin. Cases of complete dislocation have likewise been similarly reduced, but more frequently the surgeon's aid is demanded. To reduce the dislocation, the surgeon should stand in front of his patient, who should be seated in a chair with his head supported. The surgeon should then introduce his thumbs, well protected with a towel or lint, into the patient's mouth upon the last lower molar teeth and grasp the jaw with his outer fingers; he should next make pressure upon the teeth downward and backward, so as to depress the condyles from their false position, and at the next moment elevate the chin with the outer fingers (Fig. 252). Some

surgeons prefer using a piece of wood or the handle of a fork introduced between the molar teeth to depress the jaws. When strong leverage is required, as in old cases, Stromeyer's forceps may be employed. Nélaton's advice to press directly upon the coronoid processes, and Pollock's practice of applying pressure upon the chin by means of Petit's tourniquet fixed upon the head, are worthy of attention. It is well to reduce both sides together, and old standing dislocations may be thus reduced. Mr. Morley reduced one after thirty-five days, Spät after fifty-eight, Demarquay after eighty-three, Donovan one after ninety-eight, Pollock after four months, and Golding-Bird after eighteen weeks.

Fractures of the Jaws.

Fractures of the **upper jaw** are not nearly so frequent as those of the lower; and when they occur, it is generally from direct violence: when the "key" was employed for the extraction of teeth, a fracture of the alveolus was frequently the result. In severe injuries much displacement and copious hemorrhage may take place. Cases are on record where the internal maxillary artery was ruptured and fatal results ensued. The infraorbital nerve or its branches are occasionally injured, when some loss of sensation in the cheek will be produced. I have known emphysema of the cheek or orbit to follow such an injury, and have seen subconjunctival hemorrhage from it. One of the worst examples of fracture of the upper jaw I have seen occurred in a man æt. 30 from a fall from a height. Both upper jaws were completely detached from the skull and could be moved about in any direction, yet a good recovery ensued. I saw a second in an asylum, and it was caused by the blow of a lunatic's fist. In this case the whole of the alveolar process of the right upper jaw was broken off and the lower jaw fractured in two places.

Treatment.—Where *no* displacement has taken place, little treatment is required: the parts should be left alone for natural processes to effect a cure. When *displacement* exists and can be remedied by manipulation, such means should be applied, some slight retentive bandage, with or without a pad, being employed to keep the parts in position. When the palate plate is much interfered with and displaced, the dentist's aid may be called into requisition, a gold plate well adapted to the parts tending to keep the fragments together. (See Salter, *Lancet*, 1860.) Hemorrhage, as a rule, can be arrested by the application of ice or stypties. When the soft parts are injured and bleeding takes place from them, the vessel should be secured. When the bone is comminuted, there is no need for the removal of fragments; Malgaigne laid this down as a law, and Hamilton asserts that, owing to the extreme vascularity of the bones composing the upper jaw, the fragments have been found to unite after the most severe gunshot injuries. In rare cases of separation of the maxillæ a spring passing behind the head and causing pressure upon the maxillæ, after the manner of Hainsby's harelip apparatus, Heath says, might be advantageously employed.

Fractures of the **lower jaw,** like those of the upper, are, as a rule, the result of direct violence, and when produced by gunshot injuries are at times most severe. They are almost always compound toward the mouth, as the gum tissues readily give way. The body of the bone is more frequently broken than any other part, although the ramus and the neck of the jaw may be fractured. The line of fracture is generally oblique and very commonly near the canine tooth. Double fractures are very common, eleven out of twenty-four cases recorded by Hamilton being of this nature. Comminuted fractures are more rare. A case came under the care of Mr. Poland at Guy's in which the jaw, by the kick of a horse, was broken in five places.

Symptoms.—The symptoms of fracture are generally very clear, crepitus being often felt by the patient in attempting to move the jaw, and it is readily made out by the surgeon. The irregularity of the teeth is also a very characteristic symptom, and the care of the patient to hold the parts in position, conjoined with his inability to speak, is a typical sign. When any doubt exists as to the presence of a fracture, the mobility of the broken bones will disperse it. Considerable displacement sometimes complicates the case; the position and the line of fracture determine the degree: an oblique fracture near the insertion of a large muscle, as the masseter, necessarily shows a tendency to override. In double fracture of the body of the bone this displacement is usually very marked, the muscles that connect the lower jaw with the hyoid bone drawing the lower portion down. In some cases this displacement cannot be completely remedied.

In rare cases the teeth may be depressed into the alveoli, and the bone at the same

time may be broken. Such a case came under my care in May, 1882, in the person of a porter æt. 17 who in a fall off a steamer struck his chin against the edge of the quay. As a result he was rendered insensible for a brief period, and was brought to Guy's with a wound beneath the chin; there was also loosening of the left canine tooth, with a fracture of its alveolus; there was, besides, most complete depression of the two right lower bicuspid and two molar teeth, their cusps being on a level with the necks of the other teeth, and vertical splitting of one of the bicuspids and two of the molars of the left upper jaw also existed. There was likewise bleeding from the left ear, which lasted twenty-four hours, and later on paralysis of the facial nerve, suggestive of a fracture of the base of the skull. The teeth were raised by Mr. Moon, but they never became firm. Otherwise, the man quite recovered.

Fractures of the **neck of the jaw** are always the result of direct violence, and are not very readily made out. Pain aggravated by any attempt to move the jaw is a constant symptom, and so also is crepitus, perceivable by the patient. "The condyle," says Heath, "is drawn inward and forward by the pterygoideus externus, as can be ascertained by passing the finger into the mouth, and the jawbone is apt to become slightly displaced, so that the chin is turned toward the affected side, and not from it, as in dislocation." I have had under my care a man æt. 35 with a fracture of both sides of the jaw just below the condyles, and with fracture of the symphysis, produced by a severe blow upon the jaw below the chin; from the displacement that followed the house surgeon thought it was a case of double dislocation, but on attempting to reduce it it "went in" without the characteristic snap of dislocation. Ostitis and necrosis of the whole bone below the condyles followed the accident, and a new jaw formed, the man recovering with good movement of the bone.

Fracture of the **coronoid process** is very rare, and Sansom says that such a fracture never unites.

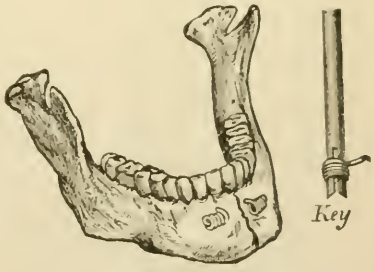
Treatment.—When the bones can be brought into apposition, the treatment may be described as simple; and where difficulties are met with in reducing the fracture, the treatment is most difficult and uncertain. In an ordinary case of fracture of the jaw, where no or very little displacement exists, the common four-tailed bandage, a yard long, with a slit in the chin-piece of about four inches, made and applied as illustrated in Fig. 253, is useful for *temporary* purposes, but for *permanent* treatment, in the few cases in which no displacement exists, it is well to mould on a splint of gutta-percha made

Fig. 253.

Bandage and Splint for Fracture of Lower Jaw.

Fig. 254.

Fig. 255.



Thomas's mode of adjusting Fractures of the Lower Jaw with Wire and Key.

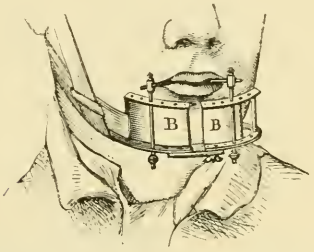
according to the shape given above (B) and applied as seen in Fig. 254, A, or, what is far better, adjust a four-tailed bandage made of five or six layers of muslin dipped in fresh plaster of Paris and moulded to the chin, the bandage being held in position whilst the plaster sets. When healthy teeth are present at the line of fracture, they may be fastened together with wire, after the method of Hammond's splint (Fig. 258).

When difficulties are felt in the adjustment, as in double fracture, where the chin is much drawn down, a good pad may be firmly tied under the chin or a block of wood adjusted. But in these cases the surgeon's ingenuity is often taxed to the utmost to meet the wants of the individual case.

Some surgeons have suggested that the bones should be fastened together by sutures when all other means fail, and Mr. Hugh Owen Thomas of Liverpool has published cases to illustrate the practice. He applies the wire ligature after the fashion illustrated in

Fig. 255, using a one-twenty-fourth-inch silver wire and fixing it with a key (Fig. 255) (*Lancet*, 1867, and pamphlet, 1875). In the case of comminuted fracture already alluded to, two or three wire sutures were applied with the best results. Others advise the use of wedges of cork so adjusted between the teeth as to maintain the jaw in its right line. Hamilton speaks highly of gutta-percha moulded to the teeth and gums within the mouth, and Tomes has invented a silver cap to fit the teeth for some distance on each side of the fracture. Barrett carries out the same idea in vulcanite. Berkeley Hill's modification of Lonsdale's apparatus is serviceable, and Moon's splint, as made for him by Millikin, is excellent. It has the advantage of all the other interdental splints already enumerated, is readily adapted to a jaw of any size, and, being introduced separately, is easily applied, and can be as readily removed, when desired, without shifting the cap, which fits the teeth on either side of the fracture. Moon's splint, therefore, seems to be the best interdental one we possess, and it should be used when simpler forms are inapplicable (Fig. 256). Mr. Moon tells me that Gunning's interdental splint is one of the most valuable for some fractures of the upper jaw, and also for fracture of the lower jaw where the teeth will not admit the use of Hammond's.

Fig. 256.



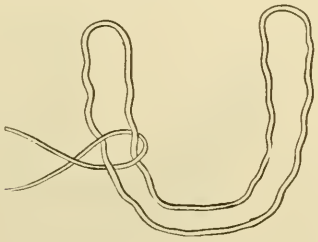
Moon's Interdental splint. (Made in two halves, BB, with horizontal rods to keep cap, Fig. 257, in position.)

Fig. 257.

Metal Cap fitted over Fractured Jaw. (Represented as wired on for a time, after the withdrawal of external splint.)

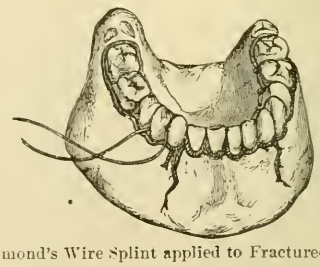
Among these simpler forms I must class Hammond's, which I had brought under my notice in 1874 by Mr. Moon. It is a very simple and valuable splint for the general treatment of fractures of the jaw, and has answered admirably in the many cases to which I have had it applied.

Fig. 258.



Hammond's Wire Splint for Fracture of the Jaw.

Fig. 259.



Hammond's Wire Splint applied to Fractured Jaw.

The following description of the apparatus and its application is given in Mr. Hammond's own words:

"I first place the patient in as convenient a position as circumstances will permit, then direct him to rinse the mouth with alcohol and water largely diluted, which not only cleanses the mouth, but removes the fetor of the breath. I next bring (temporarily) the broken ends into approximation by passing a silk thread between and round the two teeth on each side of the fracture, and then secure by tying in front. Then with a suitable tray and very soft wax I take an impression of the teeth, to which, after its having been cast in plaster of Paris, I adjust a frame of iron wire (Fig. 258), which can be done with a pair of small curved pliers. When all is ready, I slip the frame over the teeth in the mouth (Fig. 259), and while it is held in position by an assistant proceed to tie by passing small lengths of thin iron binding wire after the manner shown in Fig. 259, twisting them in front until each ligature is nearly tight, turning the ends on one side until they are secured. Next, with the aid of an assistant, I twist the wires quite tight, working alternately each side of the mouth, so as to exert an equal pressure, and thus bring the

bone into a natural position, also taking care not to overtwist or break them. I then cut off the ends and turn them in between the teeth. Now the jaw will be found comparatively firm—so solid, indeed, that the patient can bite steadily on it without pain. All that now remains to be done is to secure the jaw perfect rest by the four-tailed bandage" (*Monthly Review of Dental Surgery*, May, 1873).

It is not absolutely necessary in all cases to take a cast of the broken jaw, although it is so in some, for the surgeon may mould a frame of iron wire of the thickness that will pass between the necks of the teeth as far as possible on each side of the fracture, and fix the ends by passing them through a small tube a quarter of an inch long and bending them backward on the tube. This method is far preferable to any twisting of the ends. It has been taught at Guy's for some time by Mr. Moon.

This frame should be worn for six weeks.

DENTAL SURGERY.

By Mr. HENRY MOON.

General Remarks on Dental Surgery.

Dental surgery, in its manipulative details, must necessarily, for the most part, be left to those who make its practice a specialty; but some acquaintance with affections of the teeth and with the principles on which they are treated is required by every one who is engaged in the practice of medicine or surgery, for without such knowledge he will be unable to advise his patients on the preservation of their teeth (a subject of importance as regards their general health) or save them from the sometimes serious local complications which may attend tooth disease. Nor will he be able to diagnose the true nature of certain tumors and cysts of the jaws, or to attach the proper importance to the teeth as the possible cause of neuralgia of the head and face and of more remote nervous affections.

In the following pages only a sketch of this branch of surgery is aimed at, and the reader is referred for details to the excellent *Dental Surgery* by the Messrs. Tomes, and to the interesting pages of Mr. Salter's work, *Dental Pathology and Surgery*.

The various parts of our subject may with advantage be discussed in two main divisions. In the first section will be considered the defects in structure and abnormalities in form which may arise during a tooth's development, together with irregularities in its placement. In the second section will be considered the diseased conditions to which a fully formed tooth is liable after it has assumed its destined position in the mouth.

The effect which disease or malposition of a tooth may have on the structures immediately around it and on the general health will also be noted.

That a clear idea of these subjects may be obtained, some points in a tooth's development, structure, and connection with surrounding parts must be borne in mind.

Description of a Tooth: its Development and Connections.

A perfected human tooth (see accompanying illustration, Fig. 260) may be described as consisting of an unyielding case of dentine or ivory enclosing a highly sensitive vascular pulp; the portion of this case that forms the crown of the tooth is protected by a covering of an extremely hard substance, "enamel," which, becoming lessened in thickness as it extends down the sides of the crown, finally terminates at the neck of the tooth; the portion of the case that forms the root or roots is covered by "crusta petrosa," or tooth bone, and is implanted in the alveolar portion of the jaw; the crusta petrosa is covered externally by a sensitive and vascular membrane, "the alveolo-dental membrane," or "periodontum;" this membrane invests the root of the tooth and lines the bony socket, and is, besides, intimately connected with the dentinal pulp at the apex of the root, and with the gum also where the latter structure encircles the neck of the tooth.

Through the foramen at the end of the root blood vessels and nerves pass for the supply of the dentinal pulp, while other nerves, derived from the same source (viz., the second division of the fifth in the case of the upper and the third division in the case of the lower teeth), are distributed to the alveolo-dental membrane. The teeth are implanted

in the alveolar process of the jaw, which is developed with them and is reabsorbed when they are lost.

Development.—The twenty developing temporary teeth, enclosed in their respective sacs, are contained in the jaw at the time of birth, as are also germs of the permanent molars and those of the anterior permanent teeth; these latter, receding from their position near the surface of the gums and becoming encapsuled, gradually pass down in the rear of the temporary teeth and remain embedded in the jaw, developing at leisure within their bony crypts until wanted to replace their more fragile predecessors. (See Fig. 266.)

Fig. 260.

A Vertical Section through a Lower Molar Tooth, showing its different Component Structures and its Connection with Parts around.

The following is the normal process attending the eruption of one of the anterior permanent teeth: The roots of the antecedent temporary tooth having been absorbed, its crown is shed, and the tooth, released by the absorption of superjacent bone, gradually uprises from the gum, the protrusion of its crown taking place simultaneously with the continued elongation and development of its root.

The development of a permanent tooth thus occupies many years. Take, for examples, the first permanent molar and central incisor, the teeth which are the first developed of the permanent set. Their pulps commence to take form during fœtal life; their calcification commences by birth or in the first months of infancy. Their eruption takes place from the sixth to the eighth year, and their root canals, with their terminal foramina, are not reduced to their ultimate dimensions for two or more years later.

The three hard structures which enter into the composition of a tooth have distinct sources of origin. (*Vide* diagram, Fig. 261.)

Fig. 261.

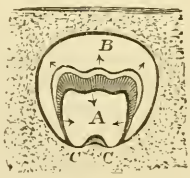


Diagram of developing Lower Molar Tooth.

A, Dentinal pulp becoming centripetally encased by dentine.

B, Space occupied by enamel organ between centrifugally forming enamel and tooth sac. In this space fluid collects in the formation of a dentigerous cyst.

C, C, The base of dentinal pulp, which remains attached and developing until the tooth is completed. By abnormal outgrowth at this point a radicular odontome would be formed.

The enamel, developed from the "enamel organ" of epithelial origin (which occupies the space B in the accompanying diagram), is formed *centrifugally* on the coronal dentine, and through the obliteration of its formative organ becomes, on the eruption of the tooth, incapable of further growth or nutritional change.

The dentine is developed from the "dentinal pulp" of vascular connective tissue (*vide* diagram, Fig. 261, A) by the immediate agency of a superficial layer of cells called odontoblasts.

The dentinal pulp or bulb, arising from the bottom of the tooth sac and projecting into its interior, grows up beneath the enamel organ and progressively takes the destined form and dimensions of the dentine just prior to the formation of that structure; thus, the free end of the bulb having taken the form of the cutting edge or masticatory surface of the future tooth, becomes capped by dentine, which forms on it from without inward, and, this crown cap being formed, the remainder of the tooth is developed by the gradual growth of the pulp at its attached surface or base (see diagram, Fig. 261, C, C) and its subsequent encasement by dentine. In the fully-developed tooth the pulp comes to occupy a comparatively constricted central chamber corresponding in form pretty accurately to the external contour of the tooth, and this chamber may be yet further diminished in size by a renewal of the centripetal growth of dentine.

Dentine, remaining as it does in connection with its formative organ through the medium of the tubuli of which it is mainly built up, is capable of a certain amount of

increased solidification, even at its periphery, and under certain conditions is endowed with most acute sensitiveness.

The crusta petrosa is formed on the gradually elongating root through the agency of the dental sac or capsule which surrounds the forming tooth crown, and ultimately comes to invest the root in the form of the fibro-vascular "alveolo-dental membrane."[1]

The alveolar portion of the jaw grows up with and is moulded around the developing teeth, and upon the eruption of their crowns affords the teeth firm implantation by closely surrounding their roots.

Having thus far traced a tooth's development, we now pass to the consideration of the effects which follow departures from this normal process.

Odontomes.

Tumors which result from the abnormal and excessive development of the dental structures at any time during the tooth's formation have been grouped together by M. Broca under the name "odontomes,"[2] and classified by him as follows:

I. **Odontomes Embryoplastiques.**—Those which arise before the dental pulp has developed odontoblasts, and before the enamel organ has acquired special enamel-forming cells.

II. **Odontomes Odontoplastiques.**—Those which arises after the special dentine- and enamel-forming cells have been developed, but prior to the formation of the coronal cap of dentine.

III. **Odontomes Coronaires.**—Those which arise while the crown is forming.

IV. **Odontomes Radiculaires.**—Those which arise during the formation of the root.

These four designations, pointing respectively to the periods in the tooth's development at which the hypergenesis of the pulp has arisen, also indicate to a certain degree the structural formation of a tumor formed at either period; but in adopting these terms it must be understood that in one sense the embryoplastic and odontoplastic conditions are present consecutively during the whole period of dentification, and also that if the odontoblast layer of cells is destroyed at any point true dentine will not there be formed, although the pulp may undergo calcification, resulting in a kind of osseous structure.

Embryoplastic Odontomes.—Under this name M. Broca ranges encysted fibrous and fibro-plastic tumors of the jaw. As the dental germ at the time of their origin contains no special dentine- and enamel-forming cells, distinctive dental structures would of necessity be absent from these growths; and such absence must of course leave their dental origin in doubt.

In one instance (mentioned by Tomes) M. Robin met with a tumor in the lower jaw of a child æt. 2 years and 6 months; this tumor, apparently fibrous, was studded with papillæ, on which distinct dentine and enamel were found. Now, whatever doubt may arise as to the origin of the before-mentioned tumors, there can be no doubt as to the dental origin of this one, and it is probable that in it a longer existence would have been accompanied by further dentification. In another odontone, which occupied half of the lower jaw of a girl æt. 2 years and 9 months, M. Broca found the formation of dentine proceeding at numerous points; and the fusion of these secondary bulbs, coated as they were with enamel organ, would result in bringing about the structural conditions found in an odontoplastic odontome.

Odontoplastic odontomes, in outward form, may bear not the slightest resemblance to a tooth.

Structurally, they consist of a more or less confused mass of dentine, enamel, and osseous structure, the dentine occurring in tracts, between which the enamel has dipped down. Enamel is also found capping nodular projections which occur on the surface.

The bulbs of one or more teeth, normal and supernumerary, may enter into their formation.

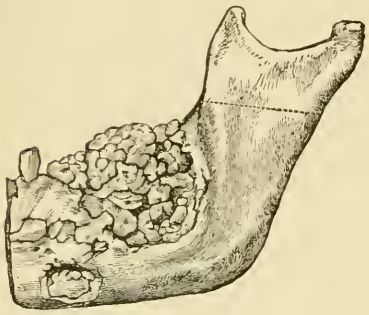
The case met with by Dr. Forget, and reported by him, may be cited as an example.

[1] From the dental sac is also probably derived the membrane known as the "cuticula dentis," or "Nasmyth's membrane," which in an unworn tooth is found continued over the crown, and is regarded by C. Tomes as an undeveloped cemental layer.

[2] Exostosis of the root and "dentine excrescence" in the pulp chamber are called by Mr. Salter "secondary odontomes" and naturally come under that designation, as might also the outgrowth of the pulp which sometimes follows the exposure of that structure; but, as these are affections of the fully-developed tooth, they will be considered in the second division of our subject.

A man æt. 20, presented himself with disease of the lower jaw from which he had suffered since he was five years old. On looking into the mouth a hard, smooth tumor was seen occupying nearly the whole of the left side of the lower jaw. None of the teeth beyond the first bicuspid were present. On removal (by section of the containing bone), this tumor proved to be a hard, oval, tuberculated mass the size of an egg, chiefly composed of dentine, with enamel investing the nodules and dipping into crevices. Between the tumor and the osseous crypt which it occupied there was a thick fibro-cellular membrane. The forming second bicuspid tooth and the crown of a molar were found impacted in the jaw through the superposition of this mass.

Fig 262.



Represents, on a much reduced scale, the half of the jaw removed in this case. (The dots across the ascending ramus mark the line of its section.)

In one case reported and figured by Tomes a large tumor presenting the appearance of a malignant growth occupied the incisive region of the upper jaw of a man æt. 25, his four upper incisors not having appeared. A probe introduced into the tumor impinged on something hard, which proved to be sundry masses of tooth structure, best described as odontoplastic odontomes, together with some ill-formed teeth. These specimens, numbering, in all, fifteen, are in the museum of the Odontological Society of London.

In a case reported by the late Mr. Harrison an odontoplastic odontome occupying the space between the incisors and molar teeth came away spontaneously. This case and the nature of other reported cases show that the extirpation of an odontome should never involve the removal of the containing portion of the jaw.

In one or two reported cases the tooth bulb, having produced an eccentric formation such as described instead of an ordinary crown, has afterward assumed normal limits and formed fairly-shaped roots.

Coronary Odontomes.—In these the main outline of the tooth is preserved, but an irregular outgrowth more or less circumscribed projects from the crown. This outgrowth, having arisen while the crown was in process of formation, consists of the coronal tooth structures—viz., enamel, dentine, and possibly enclosed pulp. If small and involving the neck of the tooth, an outgrowth of this nature may be at first mistaken for tartar.

Somewhat allied to these cases are those in which a tooth presents one or two supernumerary cusps or supernumerary teeth merged with it.

A small globular projection of enamel is also occasionally met with on the root of a tooth, and has been ranged among odontomes by Salter, who, finding that it caps a cone of dentine, calls it "a submerged tooth cusp." The crown of a simple supernumerary tooth has been found attached in the same position, and probably these cases have a like origin.

Radicular Odontomes.—This form of tumor, which in several recorded cases has attained the size of a chestnut, is found attached to the neck and root of a fully-formed tooth by a more or less constricted base, and results from an irregular outgrowth from the dentinal pulp.

Structurally, radicular odontomes generally consist of osteo-dentine more or less covered in by a layer of dentine, with a coating of cementum externally.

An odontome of this kind, embedded in front of the anterior margin of the ascending ramus of the lower jaw and passing up behind the tuberosity of the superior maxilla, was removed by me at Guy's. This tumor (see Fig. 263) was attached to the lower wisdom tooth of a woman æt. 38. The patient had experienced no inconvenience from her mouth *up to the age of thirty*, when great swelling over the ascending ramus occurred, accompanied by closure of the jaws and excruciating pain. These symptoms—*with intervals of complete cessation for two or three months at a time*—recurred until the odontome, which was gradually being extruded, was removed (very easily) by extracting the tooth to which it was attached.

In the case which is figured and reported at page 441 of this volume, Fig. 236, a symmetrical enlargement of the whole root occurred, producing a dilated hypertrophied tooth fang.

Odontoplastic and radicular odontomes are very rare, only a few cases of each in the

human subject being recorded; but the recognition of the true nature of these tumors and of others which have a dental origin is, of course, of the highest importance, as it will avert an unnecessarily severe operation for their removal. In the case of tumors and cysts of the jaws the undue absence of any tooth will point to the probability of their dental origin, but the possibility of such origin would not be excluded if the normal number of teeth were present, as a supernumerary tooth may originate either an odontome or a dentigerous cyst.

Fig. 263.

Radicular Odontome.

A glance at the close packing of teeth in a child's jaw, as shown in Fig. 268, will show the strong probability of a dental origin for tumors and cysts of the jaws in young subjects, especially when it is remembered that each of the forty-eight teeth to be seen in such jaws at one time is, or has been, the centre of developmental activity; the likelihood, also, that tumors may cause involvement or displacement of neighboring teeth will be readily realized.

Gemination, or the union of contiguous teeth, due to the fusion of their pulps, is met with occasionally in both the temporary and the permanent set. Normal teeth may be thus joined, or normal and supernumerary.

Dilaceration, or the abrupt change in the direction of the first- and last-formed portions of a tooth, sometimes occurs, and is due to a shifting of the forming tooth on its base.

Dentigerous Cysts are cysts formed by the accumulation of fluid within the dental capsule at some period of the tooth's development, or around a fully-developed tooth which has not erupted. They may, therefore, advantageously be classified, like odontomes, according to the point to which the tooth's development has proceeded when the change occurs which eventuates in their formation.

When fully developed, a dentigerous cyst usually consists of a thick membranous sac covered in by a thin osseous shell, formed by the expansion of the bone of the jaw. In a case met with by Mr. Fearn one-half of the lower jaw was expanded by a cyst which separated its external and internal plates and contained a canine tooth. In a unique specimen of Mr. Cartwright's a cyst with calcified walls containing a supernumerary tooth expanded so as to fill the antrum, while having attachment only to the floor of that cavity. The cyst at first usually contains a serous fluid, which may become purulent through the occurrence of inflammation.

The uncut tooth (temporary, permanent, or supernumerary) about which the cyst has expanded may be represented by a small shapeless calcified mass if its formation was disturbed in the earliest odontoplastic period. This fact was well exemplified by the case of a girl aged 13 who was at Guy's under the care of Mr. Cooper Forster. (See Fig. 264.) Here two small irregular masses of dentine and enamel, the representatives of an absent canine and lateral incisor, were contained in two distinct cysts, which caused great protrusion of the anterior wall of the superior maxilla. The enclosed tooth may be attached firmly to the cyst wall or may be found free within the cyst.

Fig. 264.

Case of Dentigerous Cyst not involving Antrum.

A dentigerous cyst, forming in the upper jaw, may expand into and cause distension of the antrum. Professor Baum met with a case of immense dilatation of both antra, one containing a molar, the other a canine.

In some cases the tooth crown only or the crown and part of the root have been formed prior to the expansion of the capsule by serum, and these may be said to belong to the coronary and radicular periods. In other cases, again, the cyst develops around fully-formed impacted teeth, which may be found inverted. In one instance, mentioned by Tomes, no less than twenty-eight separate and adherent denticles (or small supernumerary teeth) were found in a cyst of the upper jaw, and are probably to be looked upon as the ununited constituent parts of teeth that were missing.

Although both odontomes and dentigerous cysts have their origin in early life, years may elapse before the irritation caused by the presence of the odontome or the increasing disfigurement and pain resulting from the enlargement of the dentigerous cyst may lead a patient to seek surgical aid.

Cysts developed on the root of erupted and fully-formed teeth are not classed here as *dentigerous*, as they form only an appendage to the tooth. They will be referred to among the diseases of the teeth, but it may be here remarked that they sometimes attain to a large size, and may, like dentigerous cysts, expand into the antrum, and also that their contents under inflammation may become purulent.

Supplemental teeth—*i. e.*, extra teeth exactly corresponding to a neighboring normal tooth—are occasionally developed in both temporary and permanent sets, usually in the front of the mouth. If they cause crowding or are placed before or behind their doubles, they should be extracted.

FIG. 265.

Denticle, or most elementary Tooth Formation.

Supernumerary teeth—*i. e.*, teeth differing in form from any of the normal series—are not infrequently found in the upper incisive region, and occasionally in other parts of the mouth. A pair of teeth somewhat resembling incisors, but of greater anterio-posterior depth, are occasionally developed behind the permanent upper front teeth, and others more resembling small molars or bicuspids are also occasionally met with; but by far the commonest form that the crowns of supernumerary teeth present is that of a simple cone or of a cone truncated and fitted on its summit, and these teeth have a characteristic straight terminal line to the enamel at their necks. They are, in fact, the most elementary form of tooth formation. (See Fig. 265.)

TREATMENT.—As a general rule, supernumerary teeth are to be extracted, and will always be found to have a single root, which may, however, be contorted and expanded.

Malformed Teeth.—Abnormalities in the form of teeth may result from the dwarfing or excessive development of the different parts or lobes of which they are architecturally built up, and also from a defective formation of their enamel. These abnormalities may be of great value in the diagnosis of constitutional peculiarities and in throwing light on the condition of health present during a patient's early years.

Syphilitic Teeth.—Mr. Jonathan Hutchinson in 1860 first pointed out the association between congenital syphilis and a given misshapement of the permanent incisor teeth, and this fact may be considered fully proven. In 1875, Mr. Hutchinson drew attention at the Pathological Society to his belief that defects in enamel were in many cases due to the administration of mercury in infancy. The investigation of a large number of cases has convinced the present writer of the truth of this belief, and, in fact, when he first gave his attention to the subject, in 1868, it was apparent to him that the illustrations of syphilitic teeth given in several works were misleading, and that the malformation they portrayed was not that one distinctive of syphilis, but, if at all due to that cause, was one that had been obscured by some complication.

Certain popular teething powders, containing calomel together with an opiate, appear to be the commonest form in which mercury acting injuriously on the enamel has been administered.

The distinctive change of shape in the syphilitic tooth is essentially due to a deformed development of the dental pulp prior to its calcification; while rocky or honeycombed enamel is a result and permanent record of depressed or interrupted nutrition of the forming enamel at a particular period, brought about by the action of mercury, and probably also by illnesses which lower the system generally or disturb the circulation locally.

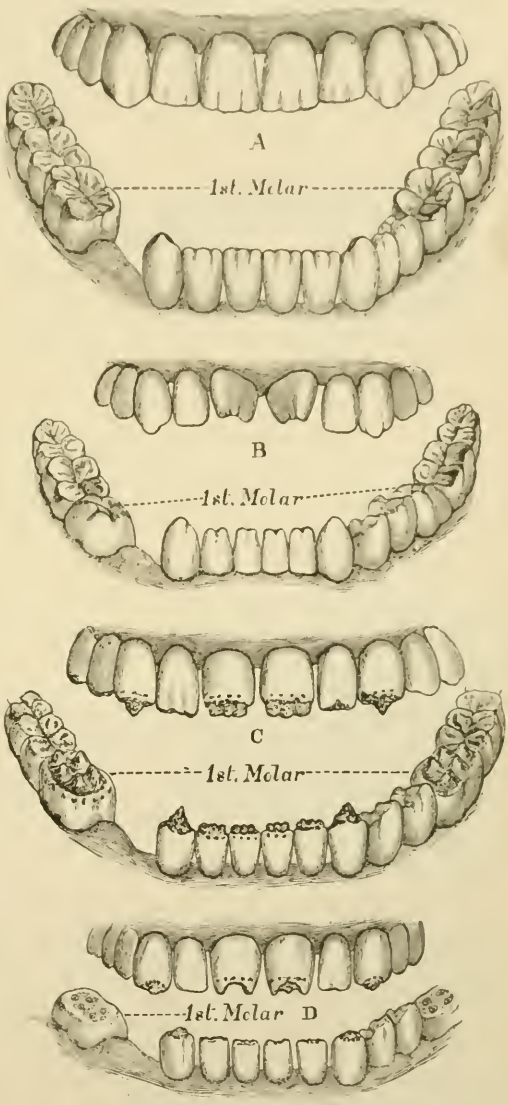
The key to the right understanding of these and other maldevelopments is to be found in an accurate knowledge of the normal forms of the teeth, and in the recognition of the fact that they are *architecturally*, though not structurally, built up of simpler forms which are liable to an individual alteration under certain pathological conditions. The distinctive features given to teeth by syphilis and by mercury are apt to be obscured by the action of both in the same case. As through this and other causes vague notions on this subject are still prevalent, typical forms of normal, syphilitic, mercurial, and what may be regarded as syphilitic-mercurial teeth are on page 459 presented at one view, together with a verbal description of their differences.

Fig. 266, A, B, C, D, represents four typical sets of teeth. The bicuspids, which in neither case suffer alteration, are withdrawn on the right side to bring the first molars better into view.

A. *Normal teeth.*—The labial surfaces of the incisors are seen built up of three equal columns and present a greater width at their cutting edges than at their necks. The upper central incisors are longer than the laterals. The first lower molars are large and angular

teeth and have five well-marked cusps, sharp-pointed through the greater prominence of a central tubercle. The upper first molars are also large teeth with well-marked cusps. The cutting edges of the incisors quickly lose their three prominences by wear.

FIG. 266.



B. *Syphilitic teeth.*—In the upper central incisors the central column is *dwarfed* and the side columns incline toward each other, causing the cutting edge of the tooth to be less in breadth than its neck. They are often much less prominent than the teeth on each side of them, through their diminished size, and also from a want of vertical depth in the portion of alveolar process in which they are implanted. Commonly these teeth have a quarter turn which brings their distal sides to face slightly to the front. The lower incisors have their cutting edges rounded off, and therefore not touching their neighbors. The first molars are reduced in size and *dome*-shaped, through the dwarfing of the central tubercle of each cusp. Syphilitic teeth may have a perfect covering of enamel, and will not then be discolored.

C. *Teeth with defective enamel.*—Aliases, "stomatitic," "honeycombed," "rocky," "*mercurial.*" Are malformed, not through a changed shape of dental pulp, but from failure of enamel to form an even centrifugal encasement over them. If the deficiency of enamel is superficial, the color of the tooth may be unaltered; but if the pittings are deeper, they usually appear as black points, or the more or less discolored dentine is revealed and imparts to the tooth a dirty "size-colored" appearance. The bicuspids, second molars, and wisdom teeth usually escape through their later development. The age at which the depressed nutrition occurred and its duration are accurately recorded on the teeth.

D. *Syphilitic-mercurial teeth.*—As regards syphilis, the contour of these teeth would be the point of chief diagnostic value. In the left central upper incisor a small central tubercle of dentine is seen denuded of enamel, which looks as if it had been gouged out from above downward; in the right central the exposed dentine has broken away, leaving a *crescentic notch*. In the first molar a depressed area is seen on the masticating surface, circumscribed by a ridge of enamel, the denuded and ill-formed points of dentine representing the cusps having been lost.

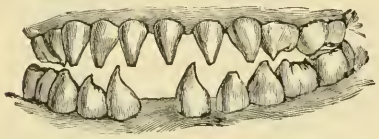
Syphilitic malformation of teeth ranges from an excessive dwarfing, in the worst cases leaving only a shapeless peg to represent the incisor, to the merest indication of the typical form. It is not present at all in some cases of congenital syphilis, and one child in a family even may escape it, while the older and younger children have it.

In honeycombed teeth an irregular and insufficient development of enamel produces horizontal groovings or pittings of its surface and most often affects the first-formed points of the cusps, sometimes leaving them entirely denuded, as shown in the figure given; but when the agency which arrests the enamel formation is brought to bear later,

the cutting edges of the incisors and the tips of the cusps of the molars will have a perfect covering of enamel and the defective lines will be below them. Sometimes, presumably when the cause has been gently exerted for a long time, slight horizontally-arranged pittings cover the whole crown.

The irregularly-formed enamel may be structurally defective, as shown by its discoloration; and this may conduce to decay, as does also the pitting of the enamel if it extends through to the dentine. In other cases the diminished size of these teeth—which prevents their being crowded and exposes their sides to healthful friction—renders them less obnoxious to decay than might have been expected.

FIG. 267.



Pointed Teeth well covered with Enamel (not syphilitic).

Some children of different families seen by me present, together with great peculiarities of their eyes and a general weakness in the development of their dermal structures, the following peculiarities in their teeth: The middle lobes are sharp, recurved, and excessively long, while the lateral lobes are dwarfed. In these cases, however, the resulting pointed form can be readily distinguished from the truncated screw-driver-like form indicative of congenital syphilis. (See Fig. 267.)

IMPERFECTIONS IN STRUCTURAL DEVELOPMENT.

At the present day the early decay and loss of teeth are very common, and are probably in part due to an insufficient supply of food containing the elements which go to build up the osseous structures, malnutrition in early life, from whatever cause, leaving inevitably its mark on the exteriors of the teeth, which, once ill formed, have no power of recuperation.

In infancy and childhood plenty of good milk and the use of "*whole* flour meal" are to be recommended; it is to be borne in mind that until a child begins to take animal food the above are the sources of supply of lime salts. The diet of the pregnant mother may also with advantage receive attention.

Structural Defects in Enamel Development.—Perfect enamel contains upward of 95 per cent. of earthy matter, and consists of rods united together without intervening matrix and placed at right angles to the surface of the dentine. Enamel, when well formed, is semi-transparent, but when defective from a want of homogeneousness in its structure presents an opaque, white, chalky appearance, and is then easily disintegrated. At the bottom of the natural sulci of otherwise well-formed teeth enamel is sometimes deficient in thickness and in soundness, and this favors the ingress of decay.

Structural Defects in Dentine Formation.—Well-formed dentine is uniformly dense and ivory-like. It is built up of tubuli and intertubular substance, the tubuli serving to convey nutrition from the pulp to the periphery. Dentine is endowed with sensitiveness through the soft tissue, which passes from the pulp to the surface and renders the dentine immediately beneath the enamel especially sensitive.

Through imperfect development a (so-called) granular layer which is found on the surface of dentine in the root may be present on the surface of coronal dentine. The (so-called) globular condition of dentine is another developmental defect. When the enamel covering is lost, imperfect dentine softens rapidly under decay without becoming darkened, and is also apt to be exceedingly sensitive.

CUTTING OF THE TEETH.

During the eruption of the temporary teeth, if there is disturbance of the general health traceable to dental irritation, and especially if there be the least sign of cerebral disturbance, there should be no hesitation in freely lancing the gum—tumid or tense—which covers the tooth that is presenting. In the case of a front tooth a straight incision should be made on to the *front* of its cutting edge; in the case of the molars a crucial incision should be made from corner to corner.

As a rule, the permanent teeth erupt very easily, but an incision with a lancet may sometimes with advantage be had recourse to in cases where cerebral disturbance is easily excited; and it is often well to remove bodily the gum from above an erupting wisdom tooth when an antagonist tooth bites upon and irritates it.

Irregularity of Position.

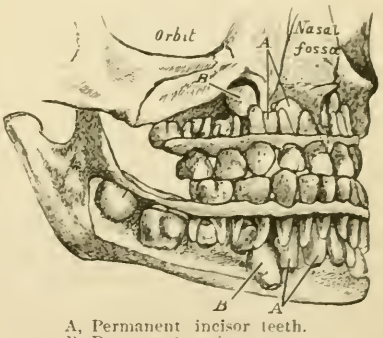
Irregularity of arrangement hardly ever occurs among the temporary teeth, but an undue prominence of the upper incisors, which sometimes is acquired through thumb-sucking and a tendency to underhanging, from the over-development of the lower jaw as compared with the upper, should receive attention, in order that these conditions may not be perpetuated in the second set. The absence of the spacing of the temporary teeth, which should precede their shedding, will point to a likelihood of crowding among the coming permanent teeth and demand watchfulness.

Irregularity of the permanent teeth often results from the want of timely extraction, and even oftener from the untimely extraction of temporary teeth. It therefore behooves the surgeon who may be called upon to extract teeth from young subjects to acquaint himself with the time of eruption of the different permanent teeth and with the points of difference between temporary and permanent teeth.

Well-developed adult jaws should consequently be thoroughly studied as a type and compared with the jaws in childhood. It will be then seen that development has occurred longitudinally backward for the accommodation of the permanent molars, while the part of the jaws that was occupied by the ten temporary teeth, having undergone additional development on its anterior face, is in the adult occupied by the incisors, canines, and bicuspids. In order that these latter may have room for even arrangement, it is important that the anterior permanent molars (the six-year-old teeth) should *not* be allowed to take up a too forward position, which they will do if the temporary molars are prematurely lost from neglected decay. On this account, therefore, the timely stopping of the back temporary molars is a practice to be recommended.

The accompanying figure will show how easily irregularities may be brought about, as the retention of the root of a temporary tooth is enough to prevent the permanent tooth from taking up its proper position.

Fig. 268.



A, Permanent incisor teeth.
B, Permanent canine.

Drawing of Jaws of Child æt. 6. (A and B point to permanent incisors and canines. The bicuspids are seen embraced by the roots of the temporary molars. The permanent molars, with the exception of the wisdom, are present.)

In judging of the amount of space that there will be for the accommodation of the coming teeth, it is to be remembered that the alveolar portion of the jaws grows up with and is moulded around the teeth it supports, and that there is a strong tendency for teeth to assume their proper position (the action of the tongue and lips conducing thereto), while the replacement of the temporary molars by bicuspids increases the space for the front teeth.

A very common form of irregularity results in otherwise well-developed jaws from the permanent upper incisors being erupted to the rear of their unshed predecessors. In such a case the prompt removal of the temporary teeth is demanded; for if, on the further elongation of the upper permanent incisor, the edge once passes behind the incisor of the lower jaw, at each closure of the mouth the evil is increased, and can then be corrected only by the use of a regulating plate. On the same score, lower incisors may sometimes be kept in the rear of the temporary teeth in order that they may be ready to wedge forward the upper incisors and thus *secure the overlapping of the upper front teeth*, which allows of their true incisive action, while it spares them undue wearing away.

In spite of the above precautionary measures at the time of the second dentition, cases of irregularity will occur from malformation and insufficient development of the jaws. Some of the slighter of these irregularities are amenable to surgical treatment—that is, a timely extraction will allow nature to set all straight; but if a tooth is taken out on one side of the mouth to relieve overcrowding, the preservation of symmetry will often demand the extraction of another on the opposite side. The patient's profile and the relative prominence of the upper and lower dental arches have to be considered in deciding whether permanent teeth should be extracted for regulating purposes, while the soundness of teeth, the direction taken by their roots, the firmness of their implantation, and their comparative durability are all points to be considered in deciding which tooth should be sacrificed for the benefit of the remainder.

Sometimes the first permanent molar may with advantage be taken out when the tend-

ency to overcrowding is decided. If this tooth, which is particularly liable to decay, is past hope of permanent preservation by stopping, its extraction in time allows the second molar to come forward and partly occupy its site and the wisdom tooth to come well into place, while it also enables the front teeth to spread and thus escape undue lateral pressure and consequent decay.

On the other hand, there is the strongest reason for preserving this tooth when the upper incisors are so prominent as to require drawing back, as it often affords the only satisfactory point from which traction can be exercised; and a bicuspid in such case should by preference be sacrificed. Another valid objection to the extraction of the first permanent molar occurs when the withdrawal of the prop which this tooth affords at the back of the mouth would cause the lower incisors to bite up unduly on to the necks of the uppers and drive them forward.

Here it may be remarked that in all attempts to improve the regularity of the teeth the relative positions of the antagonist teeth in the other jaw must be taken into account.

So far, only those cases have been considered that are capable of being benefited by timely extraction, but many cases require for their treatment the use of mechanical appliances. Among these appliances a lever for expanding the arch of the upper teeth (while it presses back the lower) and elastic bands are of great use, while in more advanced cases a regulating plate must be worn, the principle of its action being that it affords a fixed point from which continuous pressure or traction is kept up on the teeth to be moved.

The movement of teeth by mechanical means should be gradual, or absorption of bone will result without a compensatory development and the teeth will be loosened. Twisted teeth can be turned on their axes. In-standing upper front teeth can be trained out, and will be retained in their new position as soon as they are brought to overlap the lower teeth: prominent and projecting upper teeth can be gradually trained in, but will be required to be kept in place for some time by mechanical means to prevent their reverting to their original position. The lower lip passing behind prominent upper incisors increases the deformity which is usually associated with a contracted arch.

In regulating teeth much greater difficulty has to be overcome where contraction or malformation of the jaw causes the irregularity than in those cases where there is simple misdirection of the teeth themselves.

In some cases complete underhanging of the jaw is present—*i. e.*, the upper teeth, back as well as front, are set within the arch of the lower teeth; this condition does not admit of much remedy when once firmly established, but may be prevented to a certain extent by timely extraction of lower teeth together with a training out of the upper. The earlier that irregularities receive attention the better, in order that the misplacement may not be increased, and also because the moving of teeth can be safely effected only in the young.

Canine and wisdom teeth, owing to the lateness of their eruption and the position they occupy during development, are peculiarly liable to be shut out from the dental arch. The canine, being a durable tooth, should in many cases have room made for it by the extraction of one of the teeth that have closed in upon its site. The cutting of wisdom teeth is frequently attended with much trouble, and it may be remembered, in the case of young subjects with small maxillæ whose first or second molars are much decayed, that the timely extraction of either of these teeth may allow the wisdom tooth (if developed) to erupt easily and occupy a useful position. In the upper jaw, if the wisdom is forced to take an outward direction, and so cause irritation of the cheek, it should be extracted. In the lower jaw, where there is insufficient room for it between the second molar and the ascending ramus, its efforts to erupt often produce nerve irritation, chronic spasm of the masseter, the formation of pus between the crown of the tooth and the superjacent gum; it may also cause absorption of the root of the second molar and lay bare its pulp.

In all cases where the impaction of a lower wisdom tooth is a source of irritation the impaction should be at once got rid of by the extraction of either the wisdom tooth or the tooth in front. The operation required, as well as the serious results which may attend purulent inflammation about an impacted wisdom tooth, will receive notice later.

Teeth are sometimes erupted in strange positions; thus, Salter records a case of inversion and eruption of lateral incisors in the nares, and Tomes figures the case of a molar erupted in the median line of the palate, and another case in which the crown of a molar pierced the cheek at the angle of the jaw. In another case, figured by Tomes, the crown of a molar presented at the sigmoid notch, but remained impacted.

Impaction, or retention of a tooth within the maxillary bone, often occurs without any

ill results, but occasionally it is productive of severe mischief. Thus, in a case which occurred in the practice of Mr. Cartwright, Sr. (and which is reported at length by Mr. Salter), it was productive of severe neuralgia. In this case the presence of an impacted upper canine, which caused a prominence on the palate, gave rise for eight years to constantly-recurring, most severe neuralgic pain, confined to a circumscribed spot on the left side of the vertex of the head. In other cases it may give rise to cystic enlargement or abscess, the latter perhaps late in life, from the buried tooth becoming more superficial through absorption of the containing bone. The palate may be involved if a tooth is impacted within the palatine process of the superior maxilla, or an abscess may be formed below the tongue from impacted lower teeth.

The following case was reported by Mr. McCoy in the *Lancet*, 1871: A boy æt. 14 had a tumor of the antrum the size of an apricot, due to an impacted canine, the crown of which projected into the antrum, while the root was impacted in a socket in the nasal process; the antral cavity contained a little glairy fluid, but was chiefly filled by a gelatinous substance—apparently thickened mucous membrane.

Absence of Teeth.—A few cases are recorded of edentulous jaws. Wisdom and upper lateral incisors—the teeth most liable to variations in size and shape—are also the most liable to suppression. Occasionally other permanent teeth—notably, lower second bicuspids—fail to make their appearance, in which case it may be right to leave their predecessors undisturbed if they show no signs of loosening; temporary molars may in such cases serve for many years.

The tendency of particular teeth to take irregular positions and the liability of others not to be developed are facts that have to be borne in mind in connection with the probable dental origin of tumors and cysts of the jaws.

Before passing to the second division of our subject it may be useful to enumerate the morbid conditions which may be simulated by the tumors, cysts, etc. which originate from an unerupted tooth in the ways described in previous pages.

Odontomes may give rise to appearances such as may be presented by benign or malignant tumors, whether arising spontaneously or due to the impaction of a foreign body, such as root of tooth, splinter of bone, or a bullet.

Dentigerous cysts, when slowly forming and before they have thinned the enclosing bone to an extent which would allow of the characteristic sign of *craquement* on pressure, may be difficult to diagnose from solid tumors.

A dentigerous cyst may also produce the same symptoms as a cyst formed on the root of an erupted and diseased tooth; and when, through inflammation, its fluid contents become purulent, it may in like manner resemble an alveolar abscess—*i. e.*, an abscess formed around the root of a diseased tooth—and, like it, will be apt to give rise to a fistulous opening.

Empyema.—Suppuration in the antrum, or empyema, arises probably in two distinct ways. In the one case it is due to inflammation of the lining membrane of the cavity, which, being continuous with the mucous membrane of the nose, allows of the escape of the contained purulent fluid into the middle meatus by the natural orifice. In the other case the pus is contained in a sac which has expanded into the antral cavity, carrying the lining membrane before it, and then the pus does not find exit by the nasal opening; this latter condition (as pointed out by Otto Weber) is generally present when the root of a tooth originates the mischief by penetrating the cavity, and when an alveolar abscess extends into it, while cysts formed on a root and dentigerous cysts expand into the cavity in this manner and may afterward suppurate.

Diagnosis.—The history of these cases may throw light upon their nature, while a careful examination of the mouth should be made to decide whether the due number of permanent teeth have been erupted as to the existence of disease in any tooth in the neighborhood of the tumor. An exploratory puncture or opening should be made in any case that may have a dental origin before any serious operation is undertaken for the extirpation of the disease.

Treatment.—For treatment, it will here suffice to say that the complete removal of any tooth or dental formation involved is demanded, and that for the remaining treatment the ordinary rules of surgery apply.

Diseases of the Teeth.

The largeness of the nerve supply to the dental pulp and periodontal membrane, and the liability to irritation and inflammation to which these confined vascular structures are

subject, give an importance to diseases of the teeth which they would not otherwise possess; the pain, direct or reflex, which nearly always attends the involvement by disease of these dental vascular structures and the serious local lesions which may follow their suppurative inflammation often cause the mere destruction of the tooth as an organ of mastication to be a matter of secondary importance, although in itself sufficiently regrettable. Bearing in mind the description of a tooth given at page 453, it will be understood how the maintenance of a tooth in its usefulness depends on the integrity of its component structures, and how it happens that the pulp and alveolo-dental membrane, which in a condition of health are tissues simply subsidiary to the nutrition of the hard structures around them, become, when the tooth is attacked by disease, the parts which have especially to be protected from invasion.

The morbid conditions which may produce irritation of the dental nerves may with advantage be grouped in two divisions.

The first division, including those which cause irritation of the nerves supplied to the pulp with their continuation into the dentine, consists of—

(*a*) Exposure to irritation of sensitive dentine through loss of enamel resulting from caries, erosion, or fracture.

(*b*) Irritation and chronic or localized inflammation of the pulp when deprived of its protective covering of dentine through the more extended action of the destructive agencies named under (*a*).

(*c*) General inflammation of the pulp, following sooner or later on the previous conditions and resulting in its sphacelus.

(*d*) Irritation of the pulp through the presence of irregular formations of secondary dentine in the pulp chamber.

The second division, including the morbid conditions that cause irritation of the nerves supplied to the alveolo-dental membrane and to the dental nerves external to the tooth, consists of—

(*a*) Dental periostitis—*i. e.*, inflammation (plastic or suppurative) of the periodontal membrane. This results by far the most commonly from inflammation and sphacelus of the dental pulp; it may be caused by rheumatism and by syphilis or may be a symptom of salivation. It may be produced by irritation of the periodontum at the neck of the tooth where it meets the gum, and occasionally results from the undue pressure of an opposing or contiguous tooth.

(*b*) Exostosis—*i. e.*, hypertrophy of the crusta petrosa—sometimes resulting from, sometimes the cause of, irritation and inflammation of the periodontum.

(*c*) A needle-like pointing of the end of the root and a roughening of its end by absorption.

(*d*) Impaction of permanent teeth in the maxillary bones and futile attempts to erupt made by such teeth, especially in the case of lower wisdoms.

(*e*) Overcrowding of the teeth.

Irritation of the dental nerves may excite pain at the point of irritation, producing toothache, the pain being either confined to the faulty tooth or centred in it and radiating to the adjoining teeth and to the nerves of the same side of the face and head; but not infrequently it gives rise to reflex pain, in which case the tooth at fault often escapes suspicion on account of its freedom from pain. More remote sympathetic nerve affections are also sometimes caused by dental irritation.

A most unequal amount of pain or nerve disturbance occurs in different subjects from dental lesions of an apparently similar nature. Such differences must be referred to structural peculiarities of the teeth, to the conditions of health, and to the diathesis of the patient.

A faulty tooth is the real origin of many cases of neuralgia about the head and face, although cold or depressed vital power will determine the time of onset.

That remote sympathetic pain may be due to dental irritation will be easily realized by any one who has felt the distribution of his spinal nerves demonstrated on the scraping of sensitive dentine in his tooth.

Toothache (or localized dental pain) varies in character according to the part of the tooth involved; these differences will be apparent as the effects of disease in the several dental structures are considered, but it may be here remarked that a darting pain (which may fade away with an ache) betokens irritation and probable exposure of the pulp; that intense pain of a violent, throbbing character points to general inflammation of the pulp and may be expected to cease entirely with the destruction of that structure's vitality; and that the pain which attends irritation and inflammation of the periodontal

membrane is of a dull or gnawing character, but may assume a throbbing character if an alveolar abscess is formed.

Hyperæsthesia of the pulp may be expected to coexist with the conditions which act on its nerves, and is evidenced by sensitiveness of the tooth to heat and cold. A hot instrument applied in succession to the crowns of suspected teeth may afford valuable evidence on this point, and tapping the teeth may also reveal the oversensitiveness of any one tooth. Slight periosteal irritation may accompany this condition.

Dental periostitis at its onset is often attended by a sensation of fulness in the tooth which inclines the patient to press it firmly into its socket; this sensation is succeeded by painful tenderness on pressure of the tooth, which is often slightly raised and loosened, while the gum, which at first presents a narrow red line around the neck of the tooth, tends to become diffusely red and tender over the root.

In obscure cases of pain the presence or absence of circumscribed periodontitis and of irritation due to exostosis may be diagnosed by pressing the crown of the tooth in different directions, so as to tilt the end of the root against the socket; the biting of something hard with one tooth after another may also be adopted as a means of finding out if irritation of this obscure nature is present in a root.

Reflex Nerve Affections due to Dental Irritation.

The nerves of the second and third divisions of the fifth are more liable than any others to reflex affections due to dental irritation. Next to the several branches of the trigeminus, the nerves of the cervical and brachial plexuses are most often involved.

Neuralgia.—The following are the most common sites for the manifestation of reflex pain:

(*a*) Another tooth than the one in fault, frequently the one that antagonizes it in the opposite jaw, and occasionally a tooth in front of the one irritated (thus, an innocent bicuspid may ache when the wisdom tooth is at fault).

(*b*) The side of the head, with the focus of pain near the parietal eminence, due to irritation of a tooth (generally an upper back one) of the same side; this is the source of many cases of unilateral headache.

(*c*) The eyebrow, with the focus of pain at the supraorbital notch, and the cheek, with the focus of pain at the infraorbital notch, the irritation in these cases being located in the upper teeth.

(*d*) From irritation of the back lower teeth there may result earache and pain extending over the temple, and also pain passing down the neck.

Pain over the upper cervical vertebra appears generally to come on secondarily to the above-mentioned neuralgiæ.

More Remote Nervous Affections.

Pain, to quote the words of Mr. Salter, is only one of the phenomena of reflex dental nerve irritation. There may be produced muscular spasm and muscular paralysis, paralysis of some of the nerves of special sense, perverted nutrition. In these pages only an enumeration of some of these affections can be made, and the reader is referred for details of cases to the work on *Dental Pathology and Surgery*, by the above-named author, and to the second edition of Tomes's *Dental Surgery*.

The following secondary and remote nervous affections may arise from irritation in the teeth and be curable by the removal of the exciting cause:

Convulsions, etc., resulting from irritation in teething.

Epileptiform seizures. In these cases, when an uneasy sensation is felt in the mouth previous to the attack, the best results may be hoped for from stopping or extraction, as the case may demand.

Delirium from retarded eruption of wisdom teeth.

Firm closure of the mouth through chronic spasm of the masseter muscle is a frequent complication of irritation in or about the lower back teeth.

Wry neck. Pain in the course of the cutaneous branches of the cervical plexus.

Partial paralysis of the arm and hand, with an inability to grasp with the fingers, accompanied by aching pain. (Several such cases have recently been under my observation—a fact which shows their comparative frequency.)

Amaurosis. Strabismus. (Ptosis and deafness are also recorded complications.)

Ulceration in the course of a branch of the fifth nerve.

A case of obstinate leucorrhœa and acute uterine pain cured by the extraction of a tooth was recorded by the late Mr. Sercome.

One case of fatal tetanus is quoted by Mr. Tomes as having followed the operation of pivoting.

Such are some of the reflex pains and remote complications which may arise from dental irritation in a patient of neuralgic diathesis, but apparently similar exciting causes are constantly present without producing any such results.

Dental Diseases.—In an apparently sound tooth an irregular formation of dentine in the pulp chamber is sometimes the cause of neuralgic pain, and may be suspected if hyperæsthesia of the pulp exists in a tooth exhibiting no other cause for oversensitiveness.

Exostosis, and occasionally needle-pointing of the fang, may also be the cause of neuralgic pain at the root of a sound tooth, and may have their probable presence revealed by the tooth exhibiting tenderness on pressure into the socket, and perhaps later on by other evidences of periosteal irritation. Being otherwise irremediable, extraction is demanded in these not-to-be-foreseen conditions.

With the exception of the above comparatively rare cases it will be noticed, by referring to the list of morbid dental conditions given at page 464, that all the affections there enumerated may result from the spread of disease from one dental structure to another, and therefore demand treatment for their prevention and limitation. Thus, when the exterior of a tooth is the first part attacked—as it always is in caries and erosion—the aim should be to preserve the pulp from irritation and exposure; and when the pulp is already exposed through the above diseases or by fracture, the aim should be to prevent its inflammation, while, if the vitality of the pulp is past saving, means should be taken to prevent the involvement of the periodontum; and finally, if that tissue is involved, extraction of the tooth may be demanded to relieve pain and to prevent the formation of alveolar abscess with its possible complication of fistulous openings on the face, or the still graver consequences which inflammation external to the tooth may bring about.

Three facts in the nature of a tooth aid dental surgery in its conservative efforts.

The first is that the dense and evascular character of the enamel and dentine allows a diseased portion of them to be removed and the remainder to be preserved by friction or by a filling inserted in the place of the removed portion.

The second favoring fact is the continued presence on the surface of the pulp of the odontoblast layer of cells, ready to form secondary dentine over the pulp, and thus shield it, if they are stimulated to renewed action by irritation of the primary dentine.

And thirdly, the small calibre of the root canal in a perfected tooth, and the minuteness of the aperture that remains at the end of the root for the passage of the vessels and nerves, cause the pulp to be so comparatively isolated that when diseased it can with safety be destroyed by escharotics and be extirpated before its sphacelus has involved the structures external to the root.

The practical remark may here be made that up to middle age probably 90 per cent. of the teeth that are lost owe their destruction to caries, while later in life recedence of the gums and absorption of the alveolus—often prematurely induced by the presence of tartar—lead to the loss of many teeth by depriving them of implantation.

Before reviewing the agencies destructive to the teeth it will be well to consider the nature of secondary dentine and cemental exostosis, which occupy a debatable position between healthy and pathological tooth formations.

Secondary Dentine.—Three different developments come under this name. The *first*, called by Salter "dentine of repair," has been already alluded to. The loss of dentine externally through abrasion, caries, erosion, or fracture will oftentimes produce compensatory development internally at the point where the affected dentinal tubuli abut on the surface of the pulp; this reparative growth prevents pulp exposure when from attrition the enamel and a considerable portion of dentine have been worn away from the surface of a tooth, and sometimes it will obliterate the pulp chamber. In cases of decay "dentine of repair" does not often, unaided, prevent exposure of the pulp, but it hinders it and becomes a valuable auxiliary in its protective treatment. (See bicuspid, in D, Fig. 270, p. 470.)

Second Form.—Cases have been described by Salter and others in which a nodular outgrowth of dentine or osteo-dentine has projected into the pulp chamber of a sound tooth and given rise to severe neuralgia. This development must be regarded as morbid, and has been named by the above author "dentine excrescence."

The *third form*, or secondary dentine, is essentially an affection of the pulp. "Intrin-

sic calcification" is the name proposed for it by Mr. Salter, who has described its formation as thus occurring: Isolated masses of osteo-dentine form, at first usually in the axis of the pulp; these masses enlarge and merge into one another, spread toward the periphery, and may at length occupy the whole of the pulp chamber. This formation may be regarded as sometimes resulting from and as sometimes the cause of pulp irritation.

Exostosis is a term applied to enlargement or outgrowth of the crusta petrosa (see molar, in E, Fig. 270), ranging in amount from a slight general thickening (when it can hardly be regarded as pathological) to an outgrowth which may double the size of the root and sometimes has fused together the roots of contiguous teeth. The deposition of cementum may alternate with its absorption, and not infrequently it will be found thickened on the upper part of a root where chronically inflamed periosteum exists, while the end of the root will be bare of it and bathed in the pus of an alveolar abscess. It often causes a globular enlargement of the end of the root. Sometimes small excrescences of it will form on tooth after tooth, and by giving rise to most severe neuralgia will necessitate their extraction.

Exostosis may arise secondarily to inflammation of the periodontum, and will then be accompanied by extra vascularity and tenderness of adjacent gum, etc. The means for detecting its presence in its early stages, when arising primarily and causing neuralgia, have been already mentioned; symptoms that will be likely to attend its prolonged presence as a source of irritation are those of periodontal inflammation.

The nature of the agencies that destroy the dense structures of the tooth will now be considered, and, inasmuch as the sequence of disease, when once the pulp is exposed, is much the same whether the exposure has occurred through caries, erosion, or fracture, the treatment of progressive dental disease and the various affections of the pulp will be considered and illustrated once for all; and, finally, dental disease external to the root, with its complications, will receive notice.

The great prevalence of caries at the present day makes it desirable that its nature and the means for its prevention should be understood. These subjects will therefore be discussed somewhat at length.

Dental Caries, or Decay,

may be described as the disintegration of the hard structures of the tooth by decalcification. It always commences on the exterior of a tooth and saps inward; when the crown is attacked by it, a fault in the enamel is the first step in its course and may be due to original faulty development or to mechanical or chemical injury.

Fracture may produce the enamel lesion.

A frequent cause of disintegration of the enamel is the attrition exercised by the sides of crowded teeth on each other, and, as this sets up interstitial decay, a nidus is thereby formed, which serves as a laboratory for the production of chemical destructive agents which act on the adjoining tooth.

Chemical solvents are formed by acids derived from the buccal mucus and food mixed with saliva, which, lodging between the teeth and in natural depressions, undergo decomposition.

It is now also pretty clearly established that micro-organisms, which are constantly found present in carious cavities, play an important part in the disintegrating process.

Overcrowding of the teeth, viscid buccal mucus giving an acid reaction, a vitiated condition of the fluids of the mouth due to derangement of the digestive organs, the eating of sweetmeats (as carried by some young people to a most injurious extent), conduce to decay, and should therefore be avoided or prevented. The condition of the mouth attendant on fevers accelerates decay.

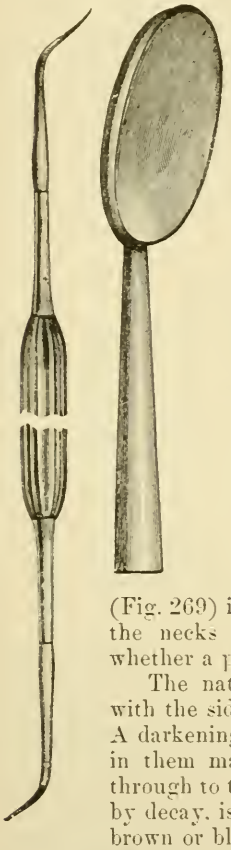
The great **preventive** of decay is friction—that is, the keeping of the surfaces of the teeth swept clean of the food, mucus, etc., that tend to lodge between or about them. With this object their lingual as well as labial and buccal surfaces should be brushed night and morning; the direction of the brushing should be always from the gum—*i. e.*, downward for the upper and upward for the lower teeth—as this removes food from between them by the natural lines of clearance; the masticating surface of the back teeth should also be brushed. Where the mucus is ropy and clings to the teeth, a saponaceous tooth powder should be used.

Rinsing out the mouth after meals is a practice to be generally encouraged, and the use of a weak alkaline mouth-wash may with advantage be had recourse to in order to

correct undue acidity of the oral fluids, and also to neutralize the local effects of strong acid medicine.

Among preventive measures must be classed what may be termed "preventive stopping." For example, a small spot of decay is often found near the distal edge (of the masticating surface) of the second temporary molar: if this be not stopped, the decayed posterior surface of the tooth will come in contact with the mesial surface of the first permanent molar on its eruption and decay be started in it; then, on the shedding of the temporary molar, its successor, the second bicuspid, will have its distal surface exposed to decay from contact with that already existing in the first molar, and thus, from lack of a small stopping in a temporary tooth, two permanent teeth are frequently lost or saved only by elaborate fillings.

Fig. 269.



The progress of decay is usually very insidious, a minute and unnoticed fault or fissure of the enamel often leading to extensive decay of the dentine. (See decay depicted on masticating surface of molar in D. Fig. 270.) A warning by pain is by no means always given, but sometimes a twinge or slight ache is experienced when the periphery of the dentine is reached and becomes irritated by saccharine or sapid substances or by thermal changes; if this warning is neglected, often nothing more is felt till an acute twinge shows that the pulp is exposed or the caving in of the enamel reveals a large cavity. It thus happens that the detection of decay in its earlier stages can be ensured only by frequent inspection of the teeth. Such inspections should begin with the first teeth and be carried out systematically several times a year if the teeth are to be preserved and much stopping avoided.

For the purpose of examination, a mouth mirror and a pointed instrument are required; the double-pointed searcher here figured (Fig. 269) is particularly useful, its curved ends being adapted to pass between the necks of the teeth; it should be employed very lightly in finding out whether a pulp is exposed.

The natural fissures and all depressions of the tooth's surface, together with the sides of such teeth as are in contact, should be carefully examined. A darkening of fissures often points to decay in their depths, and its presence in them may be considered certain if the fine point of the searcher passes through to the dentine. Enamel on the plane surface of a tooth, when affected by decay, is usually first opaque and of a chalky whiteness, but may become brown or blackened.

In interstitial decay the defect in the enamel, being out of sight, usually escapes detection, and the first evidence of its presence is given by a darkening of the underlying dentine, which darkening shows through the enamel, and in the case of a front tooth is first observable on the lingual or labial surface, and in the case of the back teeth usually on the masticatory surface. (See Fig. 270, A.) The amount of discoloration varies, sometimes a distinct black spot being visible and showing through the enamel, in other cases a smoked appearance or a slate color being imparted to the affected quarter of the tooth, the variable depth of shade being dependent on the distance from the enamel surface at which the decayed dentine lies, and also upon the character of the decay.

In young teeth, with their deficient density, decay runs a rapid course, and the pulp, being larger, is quickly exposed. The teeth of women during the term of pregnancy are apt to decay rapidly and to be peculiarly sensitive—a reason for having them put in good order in anticipation of that event.

Treatment of Decay.

To stay the progress of decay in the hard structures of the crown two methods are practised—viz., "cutting out" and "stopping." In either case the affected dental structures must be thoroughly removed and the cavity obliterated.

"Cutting out" decay is accomplished by removing adjacent sound enamel and dentine, together with the diseased portion, in such a manner that there is left an even surface of hard and healthy tooth, which should be well polished. The full depth to which disease has affected the dentine should be ascertained before the adoption of this method,

which should be had recourse to only in healthy mouths and only in cases where the cut surface will be exposed to friction.

Stopping consists in the removal of diseased structure, in the giving to the resulting cavity a retaining shape, and in the insertion into it of a stopping which is made flush with and accurately adapted to the edges of sound surrounding tooth structure.

The accurate preparation of the cavity and its edges is of the highest importance in stopping.

In practice, cutting away and stopping are often combined. Dentine left exposed should always be well polished; and if sensitive, spirits of wine may with advantage be applied to it daily, or it may be touched with chloride of zinc, or in the back of the mouth nitrate of silver or a spirit solution of tannin may be applied to it.

Various materials are used for stoppings.

Gold, skilfully inserted, gives the best results when the tooth is in a condition to bear its introduction.

Amalgams (among which the so-called gold amalgam is very good) can be introduced into a cavity in a plastic state, and therefore can be packed round corners and adapted to thin walls that might not bear the pressure necessary to consolidate gold.

Prepared gutta-percha, from its non-conduction of heat and cold, is valuable as a temporary filling, and is particularly well adapted for cavities which pass below the gum; in positions where it is not exposed to the wear of mastication it sometimes lasts for years.

"Osteo" stoppings, consisting of oxychloride or oxyphosphate of zinc, have the advantage of clinging to the walls of the cavity, which consequently requires less shaping; they are also non-compressible, which, with their property of non-conduction, renders them valuable as temporary fillings where the pulp is almost or quite exposed. They will not last long if in contact with the gum, and are not to be trusted in interstitial fillings, but for stopping large cavities on the masticating surfaces of teeth in which the pulp is almost exposed "osteo" is a most valuable substance; and if it wears away on the surface, some of it may with advantage be left in the lower part of the cavity, while the upper part is packed with gold. A saturated solution of mastic in spirits of wine (or some such preparation), mixed with cotton-wool, is serviceable as a temporary filling when a carbolic-acid dressing has to be retained in the tooth for any time not exceeding a fortnight.

Whatever stopping is used, the cavity should be kept absolutely dry while it is being filled.

The front upper teeth, which are very liable to interstitial decay, can (especially in the young) be temporarily separated by wedging them apart, thus allowing of their being filled from the side or lingual surface without interfering with their contour or leaving the stopping visible; B and C in Fig. 270 show how hidden cavities in other situations can be reached and stopped if they cannot be got at by a gradual process of wedging.

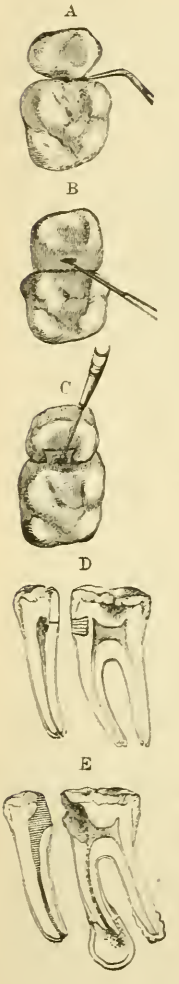
In shaping cavities for filling the proximity of the pulp with its outstanding cornua has to be borne in mind and its exposure avoided. (See molar, in D, Fig. 270.)

If a healthy pulp is exposed in preparing a tooth for stopping, a cap of some non-conducting material which has been moistened with carbolic acid should be at once placed over it, and then a stopping introduced. (See bicuspid, in D, Fig. 270.)

If an exposed pulp has become inflamed at the point of its exposure and has taken on a secreting action, repeated dressings with carbolic acid or eucalyptus oil and iodoform to get rid of this ulcerating condition may be had recourse to, and if successful a stopping may be introduced over the capped pulp; but, as a rule, if the pulp has shrunk away from the aperture of exposure or been the seat of continued pain, it cannot be preserved with comfort, and the best treatment in such a case consists in rapidly bringing about its death by the application of arsenious acid, and then, when it is devitalized, by withdrawing it and thoroughly filling the pulp chamber and its root extensions. (See bicuspid, in E, Fig. 270.)

The accompanying series of drawings (A, B, C, D, E, Fig. 270) illustrate progressive disease in a tooth, and its treatment.

Fig. 270.



A represents the masticatory surfaces of second upper bicuspid and first molar. The darkening of the decay beneath shows through the enamel on the bicuspid. A searcher is introduced to explore the mesial surface of the molar for decay.

B, the same teeth. The front surface of the molar, having presented superficial decay, has been chiselled down, which gives space for stopping-instruments to be brought to bear upon the deeper cavity in the bicuspid.

C, the same teeth with decay more advanced. The cavity in the front of molar, proving too deep for "cutting out," is reached by stopping-instruments introduced *viâ* the cavity in the bicuspid. The latter tooth, having had the enamel on its masticatory surface too much undermined for preservation, will have its contour restored by a stopping introduced into the dovetail-shaped cavity, here seen from above.

D represents continuation of disease as seen in vertical section of lower bicuspid and first molar. In the bicuspid the pulp has been just exposed, but, being healthy, has had a carbolized cap and a non-conducting stopping placed over it, and has developed a protective shield of secondary dentine. A gold stopping is seen in the molar, of a shape that would ensure its retention if solid. Commencing decay is also shown at the masticating surface of this tooth.

E, same teeth. The pulp of the bicuspid is supposed to have been destroyed with arsenious acid and withdrawn from the pulp chamber, which, with its extension to the end of the root, is represented as filled, the lost portion of the crown being also restored. The effects of unchecked disease are seen in the molar, the anterior root being occupied by purulent fluid and its apex bathed with pus of an alveolar abscess. The posterior root, in which some living pulp still remains, is represented as exostosed, but might with equal truth have been depicted as covered with thickened and inflamed periodontum.

When a pulp has been extirpated immediately after its loss of vitality, the root canals should be stopped to their apices forthwith; but when a dead pulp has remained in a tooth for any time, a thorough purification by the use of antiseptics must precede the stopping.

In some cases after the pulp has been extirpated, instead of filling the roots, an alternative plan must be adopted if the tooth is to be saved.

This consists in drilling a fine canal beneath the free edge of the gum into the emptied and cleansed pulp chamber, which is then covered over with a cap and superjacent stopping.

Fig. 271 represents a tooth so treated. The gum in this case acts as a valve opposed to the ingress of food, etc. The vent (which may be made through a stopping), by preventing the accumulation of fluid or gas in the pulp chamber, stays the development or allows the subsidence of inflammatory mischief about the root.

Fig. 271. Fig. 272.

Pivoting.—When no other teeth want replacing and the crown of one of either of the six upper front teeth is lost through fracture or decay, the operation of pivoting a new one on to the root is much to be preferred to other modes of attachment.

In the case of a healthy root the crown can with advantage be pivoted on it once for all after the end of the canal has been filled with gold or other durable stopping, but in other cases the following mode of operating is to be preferred: The canal at the end of the root is left open and the new crown is affixed to the root by a split gold pin, which is sheathed in a platinum tube fixed with stopping into the rifled barrel of the root. Here the tooth crown can be removed and replaced at pleasure, while the root is preserved from further decay by being lined with metal: and by this method a root not fully formed or one that is the subject of alveolar abscess may safely be used for supporting a pivoted crown. (See Fig. 272.)

Decay at its commencement is, as a rule, capable of satisfactory and quite or comparatively painless treatment. The difficulties of its successful treatment increase with its onward progress, while the nerve complications that have been noticed and the severe

inflammatory lesions which will be enumerated farther on are most frequently the sequelæ of neglected decay.

Fracture of Teeth.

Teeth, especially projecting upper incisors, are liable to be fractured. If only a small portion of the crown is chipped off, the fractured edge may be smoothed with a file or stone and touched with spirit to keep it hard and insensitive (filing to amend shape should not be had recourse to while the patient is very young). If the portion broken off is so large that the tooth will be permanently disfigured, and yet the pulp has escaped destructive irritation, the remainder of the crown may be removed and a new crown pivoted on to the root; in a young subject the destruction of the pulp preparatory to pivoting should be postponed until it is reduced to its ultimate tenuity by the perfecting of the root.

If it is evident that the pulp has become inflamed through the fracture, it will be desirable to at once destroy and extirpate it, in order that the periodontum may be preserved in a healthy condition, and therefore the root be in a position to carry a pivoted crown with comfort. In young subjects, when the teeth are much crowded and relatively prominent as compared with those in the lower jaw, it may be desirable to extract the fractured tooth and to train in the neighboring teeth to occupy its site.

Arrested or Carbonized Decay.—Sometimes, in young subjects, when the enamel is lost almost simultaneously over the whole masticating surface of a molar tooth, decay becomes arrested, the exposed dentine assuming a dark mahogany or black color and presenting a density which qualifies it for mastication. Such a result may be aided by the rounding off of projecting enamel edges.

Erosion.—Occasionally the enamel and the subjacent dentine are gradually lost by a process which was called by Hunter "decay by denudation," and by recent writers "erosion." The surface of the cavity so formed remains hard and polished and often free from discoloration. It is probable that this gradual wasting away of the tooth substance without any of the ordinary appearances of caries is due to the combined action of chemical solution and friction; the enamel, in the first instance, being affected over a comparatively large area, the dentine, when reached, is exposed to friction, which prevents its softening.

This erosion may affect other parts of a tooth, but usually attacks the labial surface at the neck; frequently many teeth in the same mouth are affected by it, a groove being gradually scooped in the teeth just above the gum until the pulp is exposed.

Treatment.—An alkaline mouth-wash should be prescribed and horizontal brushing interdicted; and if the exposed dentine is sensitive, either of the solutions mentioned at page 469 may be applied to it. In cases admitting of it stopping should be had recourse to, that the pulp may be preserved from exposure.

Affections of the Pulp.

An exposed dentinal pulp is subject to mechanical, thermal, and other irritation. The pain produced by such irritation is of a sharp lancinating character, sometimes passing away with an ache.

Chronic Inflammation.—Circumscribed superficial inflammation with increase of sensitiveness may be developed in the pulp at the point of exposure and may continue for a long time in an unsuspected cavity, giving rise to reflex pain or (so-called) neuralgia.

Ulcerative Condition.—The exposed surface of the pulp may take on a secretive action and the tooth be free from pain as long as the exuded sero-purulent fluid finds an exit and the pulp escapes fresh irritation.

Acute or general inflammation of the pulp is attended by terrible pain of a violent throbbing character, which after lasting several hours or days may cease as suddenly as it began, its cessation betokening the death of the pulp. In this case every factor for the production of agonizing pain is present: the distensible pulp, largely supplied with nerves, undergoes vascular engorgement within an unyielding case closed in at all parts except at the aperture of exposure, through which it may bulge and suffer further constriction. The pain is not usually confined to the faulty tooth, but spreads from it to the neighboring teeth and to the side of the face; during the paroxysms the tooth often becomes tender to pressure, owing to a sympathetic irritation of the periodontal membrane. Prompt measures should be taken to prevent the products of decomposition

which result from the sphacelus of the pulp from passing beyond the interior of the tooth, and so causing the inflammatory involvement of the periosteum and the formation of alveolar abscess.

The pulp occasionally loses its vitality without producing noticeable pain.

Tardy Destruction of the Pulp.—Instead of losing its vitality at once, the pulp may die piecemeal, the chronic irritation that attends this process often being productive of morbid changes on the exterior of the root. A pulp chamber that contains the remains of a decomposed pulp emits a strong and peculiar phosphatic smell.

Calcification of pulp has been described already under the head of "Secondary Dentine."

An insensitive polypoid growth of the pulp, consisting of granulations which throw off a secretion and readily bleed, sometimes projects from the pulp chamber into a cavity in the crown of a tooth; it usually necessitates the extraction of a tooth on account of the successful resistance it offers to extirpation.

A sensitive sprouting of the pulp may follow fracture of a tooth. Extraction would be the treatment for this condition, which, by extirpation of the pulp, should be prevented from developing if the retention of the root is desirable.

Necrosis of the pulp may occur within the unopened pulp chamber of a sound tooth. It is most often consequent on a blow (sometimes a very slight one) rupturing its vessels as they enter the apex of the root. It may supervene on fever. A darkening of the whole tooth results, and is due to the permeation of the dentine by the decomposed coloring matter of the blood.

Salter has pointed out that the pulp thus devitalized may be disposed of by fatty degeneration. In the absence of treatment—*i. e.*, extirpation of the pulp, etc.—it often leads to alveolar abscess.

A tooth knocked out and immediately replaced may become quite firm and obtain vital connection with the alveolo-dental membrane, and will then be in the same condition as the above. In this case or in cases of transplantation the replacement of the dead pulp by an indestructible filling is required to prevent after-inflammation. Death of the pulp will be evidenced by the absence of sensation in a tooth when touched with an instrument hot enough to evoke sensation in its neighbors.

Affections of the Alveolo-Dental Membrane.

Dental periostitis may be local or general, chronic or acute.

General inflammation of the periosteal investment of the teeth and their sockets results from rheumatism or attends on a debilitated or unhealthy condition of the system, and demands constitutional treatment.

Treatment.—When slight in amount and causing only a loosening of the teeth and a sense of fulness and uneasiness about them, no local treatment may be required beyond the use of an astringent mouth-wash. When the gums also are congested, they should be scarified and a stronger astringent (tannin dissolved in spirits of wine is efficient) applied to them. Tincture of iodine is a favorite application with some. Any root or tooth that may be an excitant of inflammation is best removed, and tartar should be thoroughly got rid of from beneath the free edges of the gum.

The continuance or oft-repeated recurrence of a congested condition of gum leads to the absorption of the alveolar edge and consequent loss of implantation for the teeth; the gradual deposition of tartar upon the root, besides being one of the commonest causes of this condition, is apt to attend upon and increase it when arising from other causes. When the periosteal inflammation is more acute and pus is formed about the necks of the teeth, a solution of chloride of zinc eight grains to the ounce will be found a beneficial mouth-wash and will correct fœtor.

The general symptoms of dental periostitis have been given at page 466; it may be added that when due to rheumatism toothache is apt to be present and swelling and suppuration absent; that it will often subside of itself, while in a scrofulous subject or when due to syphilis the pain is often slight and the tendency to suppurative inflammation marked; that in these cases the loss of the teeth is imminent; and that their extraction at once may be desirable. Periostitis of the alveolar process of the jaw, leading to necrosis, may be caused by a primary syphilitic chancre (apt to be mistaken for a gum-boil), also syphilis in its tertiary stage, by sloughing of the gums, by acute alveolar abscess, or may have a traumatic origin.

Rigg's Disease.—In dyspeptic patients the above conditions occur in their greatest

severity. The tumid gums, congested with venous blood, are detached from the necks of the teeth, from about the roots of which a thick fetid discharge can be pressed up. The roots of the teeth are gradually denuded of their periosteum and covered by hard dark-green nodules of tartar, while the receding edges of the alveoli disappear by caries.

Treatment.—The local treatment of this condition consists in free scarification of the gums, a thorough removal with fine special instruments of the encrusting tartar, and the application of strong carbolic acid introduced on thin slips of wood between the root and the socket which is deserting it.

Rigg, who called marked attention to this condition, recommended the removal (with strong scraping instruments) of the affected margins of the alveoli; but the thorough antiseptic treatment above described seems as satisfactory as can be expected.

The fumes of phosphorus, productive of "phosphorus necrosis," probably find a readier ingress when the pulp of a tooth is exposed, and other irritants productive of periosteal inflammation may act through the same channel.

Necrosis of the alveolar portion of the jaw in children may follow either of the exanthemata, and will not always lead to the loss of the permanent teeth if due time is given for the separation of the necrosed portion.

Inflammation of a subacute type may attack the periodontum of one tooth after another and lead to their successive loss in cases where the roots of the teeth are exposed through the recedence of the gums and alveolar margin from senile absorption or other causes.

Local Dental Periostitis.—With the exception of the condition just named, inflammation attacking the alveolo-dental membrane of a single tooth results from pre-existing disease in the tooth or is due to some local cause of irritation, such as a ligature applied carelessly for regulating purposes or for fracture of the jaw, the accumulation of tartar, or the undue and oblique pressure of an antagonist tooth. Chronic inflammation and thickening of the periodontum are often complicated either as cause or effect with exostosis or with a very small chronic alveolar abscess about the apex of a stump, and are in these cases associated sometimes with severe neuralgia.

Dental Cysts.—The dental cysts which sometimes form on the roots of teeth are probably generally the outcome of conditions which in their more sthenic form lead to the formation of alveolar abscess. An alveolar abscess may pass into a cystic condition, and it is certain that these cysts (which may contain cholesterine) may suppurate, and then, to all intents and purposes, they become converted into alveolar abscesses.

Periodontal inflammation of an acute form, producing **alveolar abscess,** is the natural sequel of death of the pulp, the products of the decomposition of this structure passing through the foramen at the end of the root giving rise to it. Pus formed between the root and its investing membrane may separate the latter from the former and escape around the neck of the tooth; in which case, if the dentinal pulp also is dead, the tooth becomes absolutely necrosed and is to be regarded as a foreign body. Pus may become diffused beneath the gum, and this is especially likely to occur in the case of lower impacted wisdom teeth. Far more commonly, pus derived from the pulp chamber or due to the breaking down of inflammatory lymph which has been thrown out about the apex of the fang is contained in a circumscribed abscess which embraces the end of the root (see Fig. 270, E) and occupies an excavation in the maxilla. Preventive treatment consists in the complete clearing out of the root canals and their thorough purification by antiseptics; this, with the administration of a saline purgative and the local abstraction of blood from the gum over the root, affords the best chance of cutting short periodontal inflammation that tends to the formation of abscess. The formation of an alveolar abscess is usually preceded by great local tenderness to pressure on or over the root of the tooth and attended by pain of a throbbing character, sometimes by rigors and considerable constitutional disturbance. The possible occurrence of pyæmia from this cause is not to be overlooked. Great serous effusion into the cancellated bone and the soft surrounding tissues not infrequently takes place, mistaken sometimes for erysipelas and occasionally resulting in suppuration; the closure of the eye of the affected side or a swelling from the lower jaw reaching half down the neck may thus be produced. An abscess connected with an upper molar sometimes causes a fulness over the lower jaw. When an abscess is formed, the contained pus tends to find an exit either through a gum-boil (so called) or by a fistulous opening on the face, etc., an opening on the gum being naturally formed when the mucous membrane is reflected from gum to cheek at a distance from the alveolar border, and a canal through the body of the bone if the root of the tooth extends below such reflection of the mucous membrane.

An alveolar abscess attached to the upper teeth may perforate the antrum, when attached to an incisor may open into the nares, or when connected with a lateral incisor may pass backward between the compact layers of the palatine process of the superior maxilla or between the periosteum and the hard palate and open through or behind the soft palate. It may also form fistulous openings on the face near the inner canthus or under the edge of the malar bone. An alveolar abscess connected with lower incisors may open under or in front of the chin and above or under the margin of the jaw when connected with the other lower teeth; from a wisdom tooth the pus may pass forward to the canine, backward to the fauces, or escape at the angle of the jaw. Pus from an alveolar abscess may pass down the neck, and in one case it found final exit below the clavicle, and in another and fatal case it reached the armpit.

The pus of an alveolar abscess that distends the mucous membrane of the gum or cheek should, of course, be evacuated by an incision if the extraction of the tooth does not suffice for the purpose. A chronic gum-boil may be regarded as a safety-vent, but abscesses with such a fistulous opening on the gum may sometimes be cured by pumping carbolic acid through the root of the tooth until it escapes on the gum, followed up by stopping of the root.

When alveolar abscess has formed and does not tend to open on the gum, but causes a distension of the bone over it, together with local inflammation, the tooth, as a rule, should be extracted without delay to prevent further mischief, although in some cases a clearing out of the pulp chamber and the performance of rhizodontropy, coupled or not with a direct opening into the abscess to evacuate the pus, may be the right practice.

In alveolar abscess of the lower jaw a prominence passing out from any diseased tooth and obliterating the natural sulcus between gum and cheek will point to the tooth which should be extracted, and a vertical incision across the abscess track within the mouth may be advisable to prevent the next step in the formation of an external fistulous opening—namely, the distension and thinning of the skin preparatory to its perforation. In these cases warm water should be held in the mouth, and poultices should *not* be applied to the outside of the face.

A fistulous opening on the face which has given exit to a continual discharge for years will at once close up on the extraction of the tooth or buried root which has caused it, but a permanent depressed cicatrix will be left; in these cases a probe introduced from the outside will very likely impinge on something which feels rough and hard like dead bone, but is really an exostosed and roughened tooth fang. Absence of fetor in the discharge and singleness of the opening point to the presence of a diseased tooth and not bone disease.

Serious Local Complications of Inflammatory Action set up by Tooth Disease.

The disfigurement of a fistulous opening on the face due to neglected alveolar abscess is comparatively common, but far more severe complications are sometimes, but very rarely, produced by the inflammatory involvement of surrounding structures. The seventh nerve has thus been involved, producing facial paralysis. Necrosis of the involved bone has led to a fatal result. Several cases are detailed by Salter in which permanent loss of sight in one eye followed antral abscess or inflammation about the upper teeth. In one case amaurosis of thirteen months' duration was got rid of by the extraction of a carious tooth from the end of which a splinter of wood projected. In the case of a patient who recently came with symptoms of tumor in the orbit into Guy's and there died, Dr. Goodhart traced the origin of mischief to caries of the first left lower molar, which gave rise to abscess, suppuration in the inferior dental canal, acute ostitis of left side of lower jaw, extension of disease by pterygo-maxillary fossa to orbit, suppuration in both orbits, ostitis of vault of skull, and pyæmia.

The spasm of the masseter which frequently attends disease about the lower back teeth is sometimes probably due to inflammatory involvement of the nerve, and not simply to reflex irritation. Extraction of the tooth is its cure, and the mouth may be opened sufficiently to allow of this being accomplished by the persevering use of a wedge between the teeth.

Tartar, or salivary calculus, consists of lime salts precipitated from the oral fluids, together with "leptothrix buccalis," epithelial scales, etc.; it especially tends to form on the lingual surface of the lower front teeth and on the buccal surface of upper molars; a small rim may be often found on all the teeth under the free edges of the gum, which

may then present a narrow blue line or be generally congested. Brushing in the manner recommended for the prevention of decay checks its deposition. Its presence in large mass may cause ulceration of the tongue, etc., and in much smaller quantity causes loosening, and if allowed to accumulate the loss, of the teeth. It should be carefully and thoroughly removed with small scaling instruments, used so as not to make the gum bleed.

All teeth that are retained in the mouth should be rendered as sound and firm as possible by stopping and scaling. A patient with tartar-loaded and decaying teeth may travel for fresh air, but will hardly find it.

All sharp and jagged edges of teeth should be removed by a file; this is of special importance in after-life, as localization of epithelioma of the tongue is frequently traceable to irritation so produced.

Tumors and other Affections of the Gums.

Sundry gum affections are intimately connected with the teeth.

Simple **hypertrophy** of the gums, chiefly on their labial surface, is sometimes met with when the teeth are overcrowded, the gum being shut out, as it were, from between the necks of the teeth. The preventive treatment for this condition is self-evident, but when it is established and extraction is inadmissible, it may be reduced by free scarification and the application of tannin, etc.

Occasionally, in unhealthy subjects, hypertrophy assumes larger proportions, the crowns of the teeth being buried in lobulated masses of gum. The treatment consists of scaling, free scarification (and sometimes excision), together with the local use of astringents and fetor-correcting applications. Absorption of the underlying alveolus, and consequent loss of implantation for the teeth, is apt to attend upon this hypertrophy, as it does upon continued extra-vascularity of the gums.

A **polypus** of the gum is frequently found to project into dental carious cavities which extend below the gum; it is vascular and insensitive, and should be cut away and packed out of the tooth cavity preparatory to the filling of this latter. This gum polypus is sometimes liable to be mistaken for polypus of the dentinal pulp.

Epulis.—The tumors classed under this name present in varying proportions a fibrous or myeloid character, and not infrequently have small osseous development at their basis. As regards the maxillæ, these growths essentially belong to the alveolar or tooth-bearing portion, and consequently can, as a rule, be completely removed without interference with the basal portion of the bone. The fibrous tissue of the gum, the endosteum, and the alveolo-dental membrane, having continuity, may each share in the development of an epulis; it therefore follows that for the complete eradication of the disease the extraction of an adjoining tooth or root may be demanded, together with the excision of the growth and involved bone.

Vascular Tumors.—Mr. Salter has recorded a case of a vascular tumor the size and color of a Morello cherry which he found attached by a narrow neck to the periosteum of a tooth. In my own practice a lobulated tumor of polypous character and having much the appearance of an epulis overlapped the hard palate, and was found to be attached by an exceedingly narrow pedicle to the edge of the periosteum of a decayed molar tooth. In both these cases hemorrhage of a really alarming extent had occurred, and in both the tumor was removed by extracting the tooth.

The painful **ulcerative stomatitis** so frequently met with in hospital practice among young children often demands the extraction of loosened and irritating teeth, coupled with the internal administration of its specific remedy, chlorate of potash.

The Extraction of Teeth.

Speaking generally, extraction may be required for regulation of teeth, which includes the prevention of overcrowding; to prevent or get rid of impaction of a wisdom or other tooth; for neuralgia and nerve irritation when its origin in a tooth is not confined to some condition of the pulp which can otherwise be got rid of; as a rule, in cases where periodontitis (not rheumatic) is established and resists curative treatment; when an alveolar abscess tends toward opening externally; in cases of vertical fracture of the tooth; in the case of loose and diseased teeth or roots which keep up an unhealthy condition of the mouth; when an epulis has probable connection with alveolo-dental membrane; and, finally, in some cases, to allow of more satisfactory artificial restoration.

Forceps and elevators are the instruments now used for the extraction of teeth. The

forceps adapted for the removal of the different teeth will be found described in Tomes's *Dental Surgery*, and only a few special points will be here noticed with regard to them and their use. Forceps should be finely made and well tempered, with blades which should grasp the tooth's neck without pressing on the crown, as extraction is seldom required for sound teeth, but for those that are broken down or hollowed out by decay.

In extracting a tooth the forceps should be applied lightly and closely to its neck and then sent firmly up (or down, as the case may be) until they grasp a part of the tooth that will resist some pressure; the edges of the blades will thus, as a rule, be made to pass just within the edges of the socket, while in the case of the molars the points of the blades will take grip at the bifurcation of the roots; the right hold being obtained by this first movement, the instrument is thenceforth kept at one with the tooth, which is first separated by a particular movement from its socket attachments and then withdrawn.

The accompanying drawing (Fig. 273) shows the manner of holding forceps. The little finger may be used as a kind of opening spring, and the thumb should act as a stop between the handles and prevent any crushing pressure.

The particular movement required for the dislodgment of a tooth depends on the shape of its root. Thus, the upper incisors and canines, together with the lower bicuspids, are more or less conical, and are therefore to be rotated; while the lower incisors and canines, together with the upper bicuspids, are more or less flattened from side to side, and therefore are to be moved outward and inward. The molar teeth are also to be moved outward and inward before being extracted.

Fig. 273.

Manner of holding Forceps.

The direction in which teeth are withdrawn from their sockets depends on the position held by their roots. Upper molars are extracted downward and outward; lower molars upward and often somewhat backward; while, in order to follow the curves of their respective roots, upper wisdoms should be extracted downward, backward and outward, while the crowns of lower wisdom teeth should be carried backward and upward.

An elevator should not be used in extracting the upper wisdom tooth, on account of the fragile nature of the tuberosity of the maxilla in which it is lodged, but may sometimes be used with advantage for a lower wisdom when the second molar is sound and firmly implanted.

Before attempting to extract a buried and impacted lower wisdom tooth a careful examination should be made with a probe to see how it is situated; sometimes it will be found to hold a horizontal position, its crown impinging upon and causing absorption of the root of the second molar. In cases where it is possible to extract the impacted tooth, lower hawksbill stump forceps with a double curve and an elevator, such as is shown in Fig. 275, B, will be found very useful. In cases where the ascending ramus would be necessarily injured in attempts to remove the wisdom, the second molar should be extracted, and then the buried tooth may erupt without further trouble or can be easily removed if still a source of irritation. Stump forceps, as here figured (Fig. 274), are far better adapted for the extraction of bicuspids than the so-called bicuspid forceps.

In the case of a much-broken-down or hollowed-out lower molar, instead of using molar forceps, it is better to grasp with stump forceps the one of the two roots which offers the best hold; and if the union between the roots is not strong enough to allow of their withdrawal together, the remaining separate root will be easily removed.

The three undivided roots of a crownless upper molar may be extracted with "Coleman's forceps," or with long flat-bladed, loose-jointed stump forceps as made by Collins.

Occasionally dividing forceps may be used with advantage in extracting united roots of either upper or lower molars.

When a root is partially covered over with gum, the position of its edges should be defined with a probe before any attempt is made to grasp it.

With well-made forceps lancing the gums before extraction is usually unnecessary, but sometimes, in isolated teeth, especially wisdom teeth, the gum is strongly adherent to the tooth, and is apt to be torn away with it if not first separated.

Fistulous openings on the face are seldom seen in connection with children's temporary teeth, but the external alveolar plate is often perforated and the end of a root projects through and causes ulceration, which may lead to adhesion between gum and cheek; the teeth causing this irritation are easily pushed out with an elevator.

Persistent hemorrhage following the extraction of a tooth and resisting cold may be stayed by tightly packing the socket with rolls of softened matico leaf (Tomes) or with

a strip of lint cut to a point and dipped in a spirit solution of tannin, a compress being placed over and kept in place by the opposite teeth. At the same time astringents or iron should be given internally if the hemorrhagic diathesis exists, or appropriate measures be taken if the bleeding in the case of a woman appears to be vicarious.

When natural teeth are lost, artificial ones unquestionably conduce to comfort and health.

Gold is generally the best base for artificial dentures when a few teeth only want restoring; but when the gums have been absorbed and many teeth lost, vulcanite or

Fig. 274.

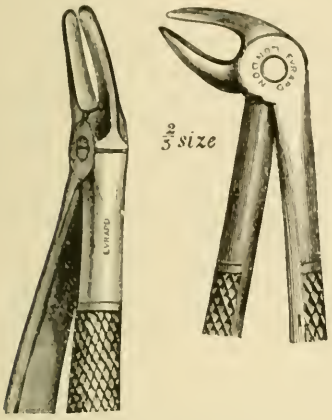


Fig. 274.—A, Upper stump forceps. B, Lower stump forceps.

Fig. 275.

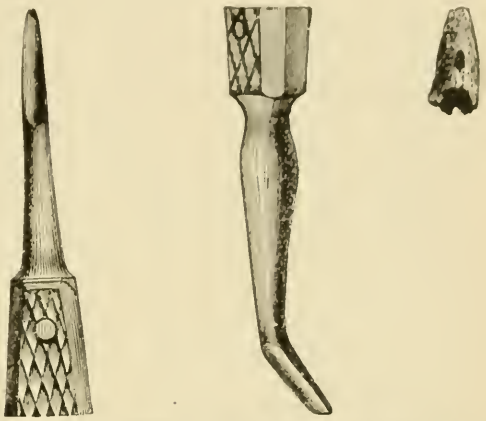


Fig. 275.—Wedge-shaped Scoop Elevators, which are very useful in extracting buried or much hollowed-out roots, such as C. A, Elevator for upper roots. B, One of a pair of elevators devised by Mr. C. Rogers for lower stumps. Such a root as C may sometimes be best removed from the upper jaw with an instrument having a spiral cut on it, used like a corkscrew.

some such substance is preferable. Various modes of fixing teeth are adopted. Atmospheric pressure alone, bands applied to the natural teeth in the least harmful way, and occasionally springs (those devised by Mr. Henry Rogers being by far the best) are each to be used in fitting cases.

In elderly people teeth that project in an unsightly manner can often be shortened with much advantage and without pain. The roots of upper front teeth and of lower teeth, if healthy, may often be retained in the mouth with gain. The wholesale and indiscriminate extraction of teeth is to be strongly reprobated, leading, as it does, to premature absorption of the alveolar processes, and thus often reducing in middle age the lower jaw to a level with the root of the tongue, and therefore ill fitted to support artificial teeth. Several painful cases resulting from extreme absorption due to this practice have lately been seen by me.

In the cases of cleft or perforate palate which are not amenable to surgical treatment artificial restoration should be had recourse to.

An obturator should span the orifice only in recent cases of perforation, in order that occlusion by the approximation of the edges of the opening may not be interfered with; and in no case should a method of fixing in the plate be used that will tend to enlarge the aperture.

AFFECTIONS OF THE PHARYNX AND ŒSOPHAGUS.

Inflammation and Suppuration of the Pharynx

are met with in the feeble and cachectic subject, and come on with general and local symptoms not unlike those of quinsy; indeed, the two affections are often associated. The chief local symptoms are pain and swelling, with difficulty in swallowing, and the chief general symptom fever with constitutional disturbance.

Abscess which may be the result of an acute or chronic inflammation of the part shows itself by some bulging or projection of the mucous covering of the pharynx, and it may be so large as to interfere with, if not to prevent, deglutition, or even to impede respiration. I have seen this occur at least twice in cases of spinal disease. When these

conditions exist, the abscess must be opened; and the best instrument to use for the purpose is a straight bistoury protected up to the point by a piece of lint or strapping. Tonics, such as quinine, iron, or the mineral acids, are almost always required in these cases. Steaming the throat gives great comfort, as well as external warm applications. Nutritious food should always be allowed. The surgeon should remember that a post-pharyngeal abscess may be due to disease of the vertebræ or base of the skull, but such cases are generally chronic. He should also be alive to the fact that such an abscess may be associated with a fracture of the spine. (*Vide* "Fracture of Spine," p. 238.)

Tumors of the pharynx may also give rise to the external appearances of a chronic abscess by pressing the mucous membrane forward; cancerous tumors are very liable to do this. One of the most marked cases of the kind I ever saw, which turned out to be a syphilitic gumma, was so large as to make me suspect its cancerous nature; it was cured by ten-grain doses of the iodide of potassium in bark three times a day.

The cancerous tumors generally commence in the upper part of the pharynx and cause obstruction of the posterior nares; as they grow downward they simulate a pharyngeal polypus. Two such cases in young people have been under my care, and terminated fatally. It was a question in both whether the disease was not originally in the tonsil, but it appeared to have originated above the gland.

Granular pharyngitis, or hypertrophy of the adenoid tissue of the pharyngeal mucous membrane, shows itself as a chronic catarrhal affection, associated with the secretion and hawking up of a thick viscid mucus, which is often tinged with blood.

There is also at times a constant burning sensation in the throat, and frequently a nasal twang in the voice. There is likewise commonly deafness. To the eye the pharynx presents a granular appearance, the granules at times being as large as peas. I have at times seen them larger—once as large as half a nut.

TREATMENT.—There is but one form of treatment of use, and that is the removal of the glandular bodies by scraping or the galvanic cautery. When the disease is limited, the latter practice is preferable; but when extensive, scraping should be employed, the operation not only removing the new tissue, but starting up a new action in the membrane which is beneficial. Tonics and the local application, later on, of glycerine and iron expedite cure.

Soft polypi grow occasionally from the pharynx. In 1883 such a case came under my care in the person of a man æt. 80. It had been growing two years and was about the size and color of a large mulberry. It sloughed off after much manipulation.

DYSPHAGIA

is a symptom due to a variety of conditions, and it may arise either from some want of power in the pharyngeal muscles or from œsophageal *ulceration* or obstruction. In the former case the condition may be due to a paralysis of the muscles of the part from cerebral disease, hysteria, or a previous diphtheria, a more or less complete loss of power in the act of swallowing existing under all these circumstances, food or fluid passing into the nose or larynx, producing suffocation. This condition is, moreover, often present after the operation of tracheotomy for croup, the want of adaptive power in the muscles of deglutition allowing liquid food to travel down the larynx and appear at the external tracheal wound.

Dysphagia from œsophageal obstruction may be brought about by either spasmodic or organic stricture of the tube itself secondary to cancerous, syphilitic, or simple ulceration. It may be produced likewise by pressure from a thoracic, cervical, or aneurismal tumor, or by the presence of a foreign body in the tube. Laryngeal and pharyngeal tumors and tumors about the base of the tongue can also produce the same symptom.

Stricture of the œsophagus, as a rule, takes place at its junction with the pharynx behind the cricoid cartilage, though it may occur at other parts. It may be *spasmodic* or hysterical, but more frequently it is associated with some simple, syphilitic, or cancerous *ulcerative* action; occasionally it is *cicatricial*, the result of a former injury, such as the swallowing of a corrosive fluid. In the majority of cases, however, the disease is due to cancer. It is a great question whether a simple fibrous stricture of the œsophagus, such as is found in the urethra, ever takes place. *Thoracic aneurism* is capable of producing every symptom of this affection.

Spasmodic or hysterical stricture is usually met with in the young, but it may be found at all ages. Paget has described it as a kind of stammering of the muscles. It is probably always associated with some local irritation, follicular inflammation,

or ulceration, which has either originated by itself or followed an injury such as a scratch from the passage of a hard or sharp body. It is, moreover, usually associated with dysphagia. The dysphagia is likewise intermittent and uncertain, and a patient, when given food or fluid to test her power, will often say that it is impossible for her to do what is required; and should she attempt to swallow, she will to a certainty half choke. Yet at other times, when otherwise engaged, food can be taken. If a probang be used to examine the part, its introduction will be violently opposed by the pharyngeal muscles, though with a little steady pressure all obstruction will be overcome.

Œsophageal Obstruction.

When a patient complains of difficulty in swallowing, or rather of difficulty in passing food onward down the œsophagus after the act of swallowing has been performed, and of its subsequent return into the mouth, the surgeon, in looking for its cause, should first think of thoracic aneurism, then of cancer of some portion of the tube, and lastly of simple or syphilitic ulceration. He should also always inquire into the history of the case and satisfy himself that in no previous period has the patient sustained any local injury from the swallowing of a foreign body, of boiling water, or of corrosive fluid. If the last cause be eliminated and a careful examination of the chest with other modes of investigation dispose of the question of aneurism, then that of cancer becomes the most important, since there is little doubt that such, in the majority of cases of organic stricture of the œsophagus, is the true cause. The minority include examples of simple and of syphilitic ulceration or contraction. In the early stages of the affection the diagnosis is difficult; indeed, at this period the surgeon is seldom consulted, for so long as solid food passes the patient is hardly aware of any obstruction existing, the habit of swallowing smaller boluses of food growing *pari passu* with the obstruction. An attack of spasm is perhaps the first symptom that attracts notice—a spasm which completely closes the canal and causes *regurgitation* of the food.

At this early period of the disease the surgeon will probably be able to pass a probang, though it may be only a small one. As the disease progresses some signs of ulcerative action may appear, such as the discharge of pus or blood, which usually comes up with the regurgitated food; and when this occurs, there is no better indication of the presence of ulcerative action. If the patient be middle-aged, the probabilities of the disease being of a cancerous nature are very strong; and should there be any local thickening behind the larynx or glandular enlargement, these probabilities are enhanced. When, however, the patient is a young adult and a history of syphilis exists, its syphilitic nature is rendered probable. Simple or syphilitic ulceration of the œsophagus is sufficient of itself to cause complete œsophageal obstruction and to simulate stricture, the spasmodic contraction of the muscles of the tube having much to do in bringing about this result. The following case, which occurred in a patient of Dr. Habershon's, illustrates these points very forcibly: The patient, æt. 48, was dying from starvation caused by inability to swallow on account of œsophageal disease, and for it I performed the operation of gastrostomy. The man lived six days afterward, and died of pneumonia. After death nearly a complete ring of ulceration was found at the upper part of the œsophagus, which had caused all his symptoms. Its syphilitic nature could not be decided, although the man gave a history of having had the disease twenty years previously. The repair at the seat of operation was most complete, the stomach and integuments having firmly united. No peritonitis existed.

I once saw, in consultation with Mr. Pink of Greenwich and Dr. Wilks, a case of complete œsophageal obstruction which we all believed to be cancerous, but which so far improved under the expectant treatment as to allow of the passage of well-minced food with comparative comfort. Several months later, however, complete dysphagia returned and the man died, a direct communication having taken place between the œsophagus and the respiratory tract from extension of the cancerous ulceration. Had a bougie been passed in this case, a fatal result would probably as a consequence have taken place.

As the disease progresses other symptoms will appear, for the ulcer may eat its way into the larynx or trachea, when it soon proves fatal. It is from this fact that the surgeon should always be very chary of passing a bougie down the œsophagus, and more particularly when there is any evidence of the presence of ulceration, since he will be very liable to do harm, and may cause perforation of the ulcer into the air-passages or pleura.

Treatment.—Assuming the pathology of stricture of the œsophagus which has been

given to be correct, the treatment by dilatation must be looked upon as a dangerous measure *except* when the stricture is of *the cicatricial form*, the passage of an instrument in cancerous or any ulcerative disease being likely to hasten the fatal termination of the disease. In the cicatricial form, however, or that which follows some local injury, such as can be produced by an irritant or caustic fluid, dilatation is of great value; and such treatment, if it does not cure the disease, will at least prolong life. A bougie as large as can be passed should be introduced daily and retained. The patient should, when possible, take solid food finely minced; and when otherwise, fluid nourishment. Milk can often be drunk when other food is refused. Beef tea is always useful, and Hassall's flour of meat mixed with it is an excellent addition. Brand's liquid essence of meat is also invaluable.

When swallowing becomes impossible, the cautious passage of a fine flexible tube through the stricture for the introduction of liquid food may be undertaken; and my colleague, Mr. Durham, has advocated its retention, the tube in some cases irritating less by its retention than by its frequent passage. The practice seems a good one when it can be tolerated. Nutritious enemata are always of great use, beef tea thickened with flour or arrowroot, with milk and egg or part of a mixture of a pound of minced beef and one-third of a pound of fresh pancreas, as a suppository, administered every four hours alternately, tending more than anything else to keep up the powers of the patient. When all these means fail—or, rather, before, for it is known that life cannot be very long maintained under such circumstances—the question of opening the stomach by an operation must be entertained.

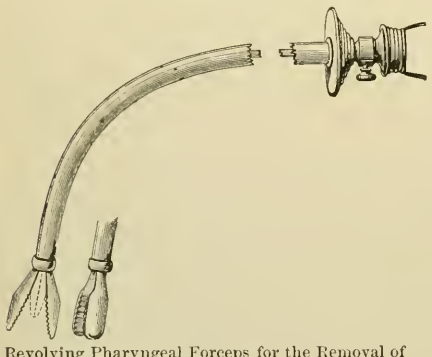
Billroth recently has cut down upon the œsophagus and excised the cancerous growth, but without success; the operation is commended to our consideration only by the eminence of the surgeon who performed it.

Wounds of the pharynx as a result of accident are occasionally met with, falling with a sharp body in the mouth being the most frequent; and when they do not involve any large vessel, they generally do well. Durham relates a case of a boy æt. 7 in *Holmes's System of Surgery* (third edition, vol. i. p. 745), in which Mr. Johnson of St. George's had to ligature the carotid artery for repeated bleedings following a punctured wound of this part, produced by the end of a parasol, in which an excellent recovery ensued.

Foreign Bodies

are occasionally arrested in the pharynx, and when pointed may become fixed in the soft parts about the base of the tongue or between the pillars of the fauces; but when bulky and solid, they are generally arrested at the narrowest portion of the tube, its lowest portion, behind the cricoid cartilage, or at the cardia. The discomfort caused by this accident is at times very great, and difficulty in swallowing, pain, and the disposition to vomit are common symptoms. A pricking sensation in the part is generally present when the substance is pointed, although it must be remembered that this symptom often remains after the substance has been dislodged. Where the epiglottis or upper orifice of the larynx is irritated, cough and other laryngeal symptoms will be produced, and the same may be said when a solid body becomes impacted behind the larynx, the larynx under these circumstances being either so compressed as to cause suffocation or so irritated as to give rise to spasm, either of these causes being sufficient to produce death.

Fig. 276.



Revolving Pharyngeal Forceps for the Removal of Foreign Bodies, etc.

When small bodies lodge in the part, they may give rise to inflammation and abscesses in the pharynx and neck; indeed, instances are on record in which disease of the cervical vertebræ has been the result. Coins may be impacted in the pharynx for many months, and Dr. O. Ward relates a case (*Path. Trans.*, 1848–49) in which a halfpenny was so placed for eight months, the child at last in a fit of coughing bringing it up.

Treatment.—Whenever a foreign body, large or small, is suspected to have become lodged in the pharynx, a surgical exploration of the mouth, base of the tongue, and fauces should be made; and by carefully sweeping these parts with the index finger any

foreign body will be detected. By this proceeding the foreign body may be dislodged. When any body is fixed in a part, it may be removed by forceps, the ordinary dressing forceps, as a rule, sufficing; when the body is lower down, the revolving œsophageal forceps as made for me by Mr. Krohne (Fig. 276) may be used. When a coin has been swallowed by a child and become impacted in the pharynx, the child should be laid across a pillow upon his belly on a table, with the head hanging over the end, and supported. The surgeon should then introduce his finger into the mouth and depress the child's tongue, the coin by this manœuvre sliding out of its place.

When a solid mass has become impacted in the lower part of the pharynx behind the cricoid cartilage and the finger cannot dislodge it, no forcible attempt should be made to push it down into the stomach, although laryngotomy may be called for to preserve life. If a second attempt to move the impacted body fail, it is well to desist, as by the lapse of time the spasm which existed when the first attempt failed may disappear, and a renewed effort may be crowned with success. Soft bodies likewise become softer, and consequently can be the better removed or pushed downward. A good deal may, however, be done by digital manipulation, both inside and outside the mouth, either to dislodge the foreign body or to so alter its shape by squeezing as to enable it to pass downward. The laryngoscopic mirror is often of great service in detecting the presence of a small impacted body and in guiding the surgeon to its position. False teeth not infrequently become dislodged and impacted in the pharynx. Paget has related such a case,[1] where a man in a fit had one of his sets in the pharynx, where they remained four months. They were afterward dislodged from between the base of tongue and the epiglottis.

Before giving chloroform to old people the teeth always should be examined and false sets removed. When such bodies become impacted, much care is needed in their extraction, and the utmost gentleness used.

Foreign bodies in the œsophagus are mostly arrested at the two narrowest portions of the tube—its origin behind the cricoid cartilage, or at its lower end just above the diaphragm—and anything that can be swallowed may be so impacted. The symptoms to which this accident gives rise are extremely uncertain. When the upper part of the tube is obstructed, the laryngeal symptoms are generally alarming (Fig. 277); and when the obstruction is not complete, they may be very slight. Vomiting, however, under both circumstances, will probably take place to expel the obstructing body; and when this is severe, *rupture of the œsophagus* may ensue. This accident is to be suspected when, after severe and repeated straining, the foreign body is ejected with violence, its ejection being attended with hemorrhage and followed by emphysema of the neck. An interesting paper on this subject may be referred to, by Dr. Fitz (*American Journal of Med. Science*, January, 1877). As a rule, however, besides the mechanical symptoms which the mere presence of a foreign body in the tube produces, secondary inflammatory symptoms may be set up which may give rise to a fatal result. Thus, a case is on record in which a fish bone perforated the heart and caused a fatal hemorrhage (Andrews, *Lancet*, 1860); in another, where a sharp spiculum of bone caused ulceration on the third day into the aorta (Hume-Spry, *Path. Trans.*, vol. xix. p. 219); and in a third, where disease of the spinal cord ensued as a consequence of ulceration of the intervertebral substance following the arrest of a piece of bone in the œsophagus (Ogle, J. W., *Path. Trans.*, vol. iv. 1853). Erichsen also records a case in which a piece of gutta-percha formed for itself a bed in the wall of the œsophagus for upward of six months, and destroyed life by causing ulceration into a vessel and hemorrhage; and a second, in which a man died suddenly from hæmatemesis, the cause being discovered after death to be a half crown impacted in the œsophagus, ulcerating into the aorta. Gairdner likewise gives a case where a fish bone passed through the posterior wall of the œsophagus and was found embedded in pus in front of the vertebral column (*Med.-Chir. Soc.*, Edinburgh, 1859), and my friend Dr. Sutton also has told me of an instance where a lunatic so plugged his pharynx with tow as to cause death by suffocation.

FIG. 277.

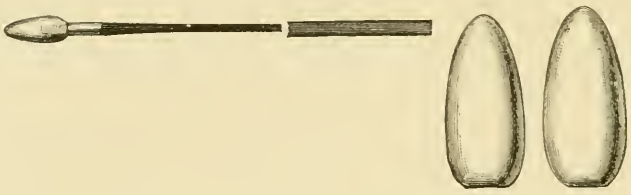
Preparation showing a Piece of Pudding impacted in Œsophagus of a Child æt. 2 years, which caused Death by Laryngeal Spasm. (Guy's Hosp. Mus., 1793ᵃ.)

DIAGNOSIS.—It is impossible for a surgeon under all circumstances to say with cer-

[1] *Med. Times*, 1862.

tainty as to the presence or absence of any foreign body in the œsophagus. When it can be felt by the finger or bougie, no doubt can be entertained; yet, on the other hand, when no such evidence is obtainable, a foreign body may often be present, and, being of

FIG. 278.

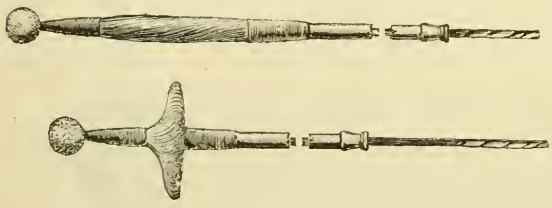


Œsophageal Bougie with Metal Olivary End.

small size, may become so fixed in one side of the tube as to escape detection in the passage of an instrument. The best bougie for diagnostic purposes in one made of whalebone with a smooth polished iron knob at its end (Fig. 278), the one with a sponge at the end being useless.

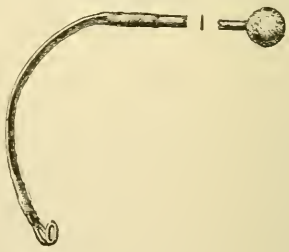
TREATMENT.—When a foreign body is detected, the sooner it can be taken away the better. If the material be *soft* and *digestible*, it may be pushed downward by means of an ordinary sponge or ivory probang or the tube of a stomach pump, care being taken not to use force, for such material will soften by the natural secretion of the part after the lapse of a few hours, and thus will be more readily pressed on. Should, however, the offending body be pointed, hard, or large, all idea of pushing it on must be dismissed, such a practice being most dangerous, although it has been done with impunity, a jagged plate with teeth having been pushed into the stomach and passed per anum. *Small pointed bodies* may be caught by the "horsehair" probang (Fig. 279), passed carefully

FIG. 279.



Horsehair Probang, Expanded and Unexpanded.

FIG. 280.



Money Probang, with Sponge at one End.

beyond the position in which the foreign body is supposed to be placed, and then gently expanded, rotated, and withdrawn, the compression and rotation of the instrument causing the hair to spread out and to expand the œsophagus. The addition of a skein of silk to the extremity of the probang adds at times to its value. *Sharp-pointed bodies or impacted hard irregular bodies* should, when possible, be removed by forceps. Those figured in No. 276 are the best, as they can be made to open when in the pharynx in all directions.

Vomiting will often cause the dislodgment of a foreign body, though at times it may render it more fixed. When vomiting cannot be produced by the administration of medicine, a solution of tartarized antimony, or of apomorphia gr. $\frac{1}{10}$, injected beneath the skin is said to act as well.

Coins and other flat but not pointed bodies can often be removed by means of the money probang (Fig. 280) or Graafe's coin catcher, the circular hook catching the coin and drawing it upward.

Swallowing a large bolus of bread may carry downward any fine bone or bristle, a draught of any liquid assisting the process.

Œsophagotomy for the removal of foreign bodies has an established position in practical surgery, and the principles laid down many years ago by Arnott[1] are now generally accepted—viz., "Where a solid substance, though only of moderate size and irregular shape, has become fixed at the commencement of the œsophagus or low down in the

[1] *Med.-Chir. Trans.*, vol. xviii.

pharynx, and has resisted a fair trial for its extraction or displacement, its removal should *at once* be effected by incision, although no urgent symptoms may be present." Mr. Cock endorsed this opinion when he wrote in 1867:[1] "The longer a foreign body is allowed to remain, unless we wait—a forlorn hope—for suppuration to loosen it, the more firmly it will become impacted. It would appear that success attends a speedy operation; whereas, where the use of the knife has been delayed until local inflammation, suppuration, or even sloughing, has been established, the result of the operation has been fatal." Dr. D. Cheever of Boston, U. S., likewise urges it. Up to the end of 1882, 45 cases of this operation for the removal of foreign bodies were recorded, and of these 35 were successful, and in the fatal cases the result was more from the delay than the operation.

This operation has been recently advocated in cases of stricture, cancerous or otherwise, with the view of introducing food permanently into the stomach; but the results of the operation are not sufficiently satisfactory to enable me to advise its adoption. It is only possible when the seat of stricture is high up, and advisable when the stricture is of the cicatricial form; under other circumstances, gastrostomy should be preferred.

Operation.—The patient should be placed in the recumbent position, with his shoulders slightly elevated, the head being turned to the right or left side, according to the point of projection of the foreign body. Where this guide is lost, the left side should be selected, the œsophagus inclining rather to that side. An incision should then be made along the anterior border of the sterno-mastoid muscle, about four or five inches long, its centre corresponding to the position of the foreign body, and all the soft parts carefully divided. The omo-hyoid will then come into view, and underneath this the carotid sheath, with its vessels, will be seen. The deep cervical fascia is then to be laid open; and if more room be required, the sterno-hyoid and sterno-thyroid muscles may also be partially divided. The vessels, with the sterno-mastoid muscle, should then be drawn well outward by means of hooked retractors. The larynx, with the œsophagus behind, can then be examined and the position of the foreign body accurately made out, pressure with the finger on the opposite side tending materially to make this point clear. Should the foreign body project, the larynx may be drawn well forward or toward the opposite side and a cut made down upon the projecting part, the wound being carefully enlarged to allow of an extraction without force. When the foreign body does not project, a guide should be used, such as a silver catheter, flexible lead or tin sound, or a long pair of forceps introduced through the mouth downward into the pharynx, the point of the instrument pressing forward the œsophageal wall. All vessels that bleed during the operation should at once be twisted or ligatured. On opening the œsophagus the recurrent laryngeal nerve should be carefully avoided. The wound should be left open. The patient must be fed for a few days by means of a small œsophageal tube, introduced through the mouth into the œsophagus below the wound, care being taken during its introduction to keep the point against the opposite wall. Convalescence, as a rule, goes on steadily. I have been fortunate enough to see the operation successfully performed twice by my colleague, Mr. Cock, and the facility with which it was done has given me a very favorable opinion of its value.

CHAPTER XIV.

INJURIES OF THE ABDOMEN.

Contusions and Rupture of the Viscera.

Injuries of the abdomen, like those of the cranium, derive their principal importance from the nature of the cavity's contents. The integuments and muscles that form the abdominal parietes may be severely injured and results follow which are simply of local importance: but when the peritoneal lining of the cavity is involved or any of the viscera are injured, the case assumes a grave aspect. The gravest internal abdominal injuries may, however, coexist with the slightest or with no external evidence of mischief, and even without shock. When a wound is present, an extra element of danger is added which is to be measured by the extent and character of the visceral complication.

[1] *Guy's Reports*, 1858, 1867.

Under certain conditions a trifling blow on the abdomen may give rise to symptoms of an alarming nature, when a severe one may be recovered from without exciting more than a fear. "The absence of shock immediately succeeding a severe lesion may lull suspicion, as its presence may by simple contusion excite alarm." Every abdominal injury, however trivial it may appear, must consequently be regarded with apprehension and the utmost care observed in its treatment. This can be easily accounted for, says Poland,[1] "when we consider the numerous and vital structures contained in the abdomen —a serous membrane highly prone to inflammation: the 'peritoneum,' occupying an extensive amount of surface; a lengthy coil of organized tubing, 'the stomach and intestines;' solid substances, made up chiefly of blood vessels, etc., the liver, spleen, and kidneys, readily lacerable and liable to rupture, causing nearly always fatal hemorrhage; receptacles for fluid, 'the gall and urine bladders,' which under distension and undue force may burst; large vessels coursing along the posterior wall, 'the aorta, vena cava,' etc.; and lastly, above all, the sympathetic nerves, consisting of the solar plexus and its numerous satellite plexues and branches of such high organic importance that injury or shock thereto may be attended with irreparable results. All these structures are, moreover, enclosed with soft elastic parietes capable of great distension, which, although readily able to resist shock and external violence without injury to themselves, yet may allow the force to be transmitted and expended on the contents with dire effect, and yet without leaving a trace or mark on the exterior."

In forming a diagnosis in this class of cases exclusion is the only sound method; every possible complication should be entertained and dismissed only when the weight of evidence is against it, the ultimate conclusion being founded as much on negative as on positive evidence.

"I am unacquainted," writes Le Gros Clark (*Surgical Diagnosis*, 1869), "with any diagnostic sign by which we may predicate whether shock following an abdominal injury exists primarily, apart from, or as expressive of, actual breach of texture. Time alone can develop the true nature of the case, either by renewal of vigor or by the development of fresh symptoms."

An injury to the abdomen from a blow, fall, or the passage of a wheel over the part may cause either a more or less severe contusion of the abdominal wall with no visceral complication whatsoever, or a laceration or rupture of a viscus or vessel which will end in death, without any (or very slight) external sign of mischief.

Shock or **collapse** as a direct consequence of a blow, when of a passing nature, is of small value as a diagnostic sign, although when *persistent* or *relapsing* it indicates great mischief, as more or less complete collapse is a common effect of all abdominal injuries. A collapse, however, coming on at a distinct interval of time after an injury, as a rule, indicates internal hemorrhage.

Pain as an immediate effect of injury is no indication of internal mischief, for in simple abdominal contusions it is at times very severe. When, however, it *lasts* or becomes *fixed*, it is a symptom of importance; and when it *radiates* from a point, it is most characteristic.

Persistent vomiting is always a suspicious symptom of visceral injury.

How far sudden death is attributable to a shock or collapse from a blow on the epigastrium or stomach without organic lesion is not yet a settled question. Dr. A. Taylor in his *Medical Jurisprudence* adduces a case, that of Mr. Wood, in which a man, when fighting and intoxicated, suddenly died after the receipt of a left-handed blow on the pit of the stomach; but the evidence in the case, as well as the facts revealed at the post-mortem, was by no means conclusive as to the cause of death. The opinion has probably been accepted on the authority of Sir. A. Cooper, who was in the habit of relating that as two men were working, one of whom was wheeling along a heavy load, his comrade thus addressed him: "That is too much for you; stand aside, and let me, a better man, take it." He accompanied these remarks with a slight blow on the scrobiculus cordis, and the man immediately let the barrow fall and died on the spot. After death no lesion was discovered. The case, however, had only been related to Sir A. Cooper. Surgeon A. Harding, of the Army Medical Department, in his *Report*, 1881, vol. xxi., Appendix No. VII., gives a case "the history and post-mortem appearances of which apparently point to sudden death the result of shock to the sympathetic system of nerves, paralyzing the cardiac plexus, and thus causing cessation of the heart's action. The man, as far as can be ascertained by inquiring of his intimate comrades and examination of his medical history sheet, had been previously perfectly healthy, thus excluding heart disease, and

[1] *Guy's Rep.*, 1858.

no traces of injury being found leads fairly to the above conclusion." The case was that of J. Coyle, an officer's servant, who in driving away a pony from his master's tent received a kick from the animal over the region of the liver. He at once said to a comrade standing near him, "I'm done for," and fell down dead. Dr. Harding saw him so five minutes after the accident. At the autopsy, made twenty-two hours after death, all the viscera were found healthy; lungs collapsed; heart full of fluid blood; liver normal in size, but full of blood; spleen and kidneys also full of blood. I concur, however, with Mr. Pollock, that "sudden death attributable to a blow on the stomach or epigastrium must be a rare occurrence, and that medical men should be extremely guarded in offering an opinion as to the cause of death in such supposed injuries without satisfying themselves by most careful and minute post-mortem investigation that no violence has been done to the viscera, either abdominal or thoracic" (*Holmes's System*, 3d edit., vol. i. p. 867).

What, then, it may be asked, are the usual consequences of an abdominal injury or contusion, and what are its risks and complications? The following facts will answer these queries.

At Guy's Hospital, during eight consecutive years, seventy-one cases of abdominal injuries were admitted. In *seventeen* cases, or about one-fourth of the whole number, rupture of the viscera took place. In *forty-four*, beyond a passing collapse and tenderness over the injured part from the contusion, no evidence of any internal mischief showed itself. In these cases rest in bed for a few days, with the local application of a warm fomentation, was the chief treatment, and in all convalescence was rapidly established. In *ten cases* symptoms of *peritonitis* followed, as evidenced by excessive tenderness over the injured part, increased by movement, thoracic respiration—resulting from the indisposition of the abdominal muscles to act, and the pain caused during that action by pressure on the inflamed peritoneum—nausea, and in some cases vomiting. Fever and constitutional disturbance varied according to the severity of the inflammation. In seven of these ten cases *absolute rest* in the horizontal posture, warm local applications, either by means of fomentation or cataplasms, in some instances leeching, and *in all opium* given in moderately full and repeated doses, was the treatment adopted; and in every case the inflammation was subdued before it had attained a dangerous degree of severity. In the remaining *three cases*, however, acute peritonitis set in, which in one terminated fatally. As a type of an ordinary case of peritonitis after injury, I adduce the following case:

A man æt. 22 received from a woman, while fighting, a blow on his right side, which was followed by syncope, but from which he soon recovered; no pain or inconvenience followed the injury for a week, and the man resumed his usual occupation. At this date severe abdominal pain appeared at the seat of injury, which rapidly increased and spread over the whole abdomen; vomiting also began, accompanied with considerable constitutional disturbance; and in this condition he was admitted into Guy's. He was put to bed, twenty leeches were at once applied to the seat of injury, and a grain of opium given, which was ordered to be repeated three or four times daily; perfect rest was also enjoined. In a few days these symptoms subsided and he was enabled to take food without vomiting, pain ceased, and convalescence became gradually established.

Remarks.—Such a case is interesting from the fact that some days elapsed between the receipt of the injury and the appearance of the peritoneal symptoms, as well as from the important practical point to be learnt from the rapid success that followed upon the treatment which was pursued. Rest to its fullest extent was, doubtless, the chief element of success—rest by position in the horizontal posture, and rest of the injured parts maintained by the administration of opium. It is not unfair to maintain that if this treatment had been adopted earlier, the symptoms exhibited would never have made their appearance; but, the man following his occupation, the repair which was required after the injury could not be efficiently carried out, and, as a consequence, inflammation ensued. Of all cases, abdominal injuries require absolute rest, and in no example, however, apparently trivial, should it be neglected. If the mischief is but little, that little will more rapidly be repaired; if great, its evils and its consequences will be materially modified. The case already quoted indicates both points—viz., its primary necessity and its secondary good results.

It is thus seen that a blow upon the abdomen may be followed by a simple contusion of the abdominal wall, and in exceptional cases by peritonitis, which may terminate fatally, although in the majority where such a result ensues it is from rupture or lesion of some internal part. A local peritonitis after an injury is not, however, to be looked upon with displeasure, for, as pointed out by Mr. Hilton, the coagulable lymph which is poured out under these circumstances forms a temporary splint until the injured struc-

tures repair themselves. The inflammatory effusion produces a certain degree of rest to the injured structures, and thus contributes to the work of reparation.

What, then, are the symptoms of an internal abdominal lesion? How can the presence of such be made out? And what guides are there to the viscus that is wounded?

To answer these questions satisfactorily much space is needed—more, indeed, than can well be spared in this work; yet helps to diagnosis may be given, and among these the nature and position of the injury are the best. Where the loins are the part involved, the kidneys are most likely to suffer; where the right hypochondriac region, and the ribs on that side are fractured, the liver is probably the organ that may be injured. When the injury is on the left side the stomach or more probably the spleen, when in the umbilical region the intestines, when in the pelvic region the bladder, are the organs involved.

Rupture of the liver usually destroys life by hemorrhage, and in the majority of cases within a few hours of the injury—in some within a few days. Thus, out of nine consecutive cases of ruptured liver, five died rapidly; three survived three, seven, and nine days respectively.

There is little doubt, however, that recovery may take place when the fissure is limited and the case uncomplicated. Preps. 1948–1951[5] in Guy's Hosp. Museum, with drawings, illustrate this truth. Such cases, when they occur, are classed with those of traumatic peritonitis; and when they prove successful their true nature is not revealed.

When the laceration is *extensive*, death is always speedily produced by the shock and hemorrhage; coldness and general pallor of the whole body, with a feeble pulse, sighing respiration, and restlessness, preceding the fatal issue. When the laceration is *less severe* life may be prolonged; and I have recorded in another work the case of a man æt. 45 who when drunk fell from a cart and the wheel was said to have passed over his head. Intoxicated to an extreme degree, he was admitted, under Mr. Birkett's care, into Guy's Hospital, presenting no collapse or symptom of abdominal, or even cranial, mischief, beyond slight hemorrhage beneath the right conjunctiva. He was put to bed, soon fell asleep, and on the following morning, with the exception of the hemorrhage into the orbit, *no signs* of mischief could be detected. Rest, however, in the horizontal position was strictly enjoined, but to this he would not submit; and thirty-six hours after the accident he got up, walked about, and with a sudden pain in his side fell back and died. After death a fissured fracture of the skull was found passing across the right orbit, without brain complication, and about a pint of blood in the peritoneal cavity, which had evidently escaped from a severe laceration of the liver, a mass, situated in the right lobe, the size of a man's fist having been nearly separated. The right kidney was also fissured on its surface and covered with coagulated blood. In this case the man clearly died from secondary hemorrhage the result of the ruptured liver. In October, 1883, a boy æt. 16 *walked* into Guy's Hospital, although in pain, after the wheel of a cart had passed over his abdomen. There were no external signs of injury, and the only prominent symptom was vomiting. He appeared to be doing well, when on the fifth day, after an action of the bowels, he suddenly died. After death a fissure three inches in depth was found in the right lobe of his liver, filled with clots and covered with lymph.

In rare instances the liver may be crushed partially and, strange to say, its peritoneal covering be uninjured; yet in such cases life can be prolonged, and when the mischief is not extensive may be saved.

Fissures of the liver are usually met with on its upper surface, and a diseased organ is more liable to rupture than a healthy one.

The spleen is frequently injured, and such cases are by no means always fatal. Prep. 2018, Guy's Museum, illustrates its repair after injury. This organ, too, is sometimes lacerated by a fractured rib or torn by a dragging of its surface. When fatal, the result occurs from hemorrhage or peritonitis. A child æt. 5 was run over and admitted with fracture of the *left* ribs and lower jaw. He had no abdominal symptoms. On the tenth day he sat up, when symptoms of acute peritonitis set in, followed by death on the twelfth day. After death pleurisy and fractured ribs were found, with blood in the left loin and four ounces of blood and pus between the surfaces of a ruptured spleen.

Subdiaphragmatic abscess may occur as a consequence of abdominal injury, and the surgeon should suspect its presence in all cases where recovery is slow and attended with abdominal pain.

Rupture of the stomach generally proves fatal from shock or irrecoverable collapse, the amount of distension of the organ, its contents, and the extent of laceration influencing the result. When the rupture is large and effusion of its contents into the

abdominal cavity takes place, acute peritonitis, with or without hemorrhage, will prove fatal, if the shock does not. When the rupture is small and the stomach empty, there is some chance of recovery, local peritonitis subsequently gluing the injured part to the surrounding tissues.

When death is not immediate, the patient will complain of an acute and constant pain radiating from the seat of injury—so peculiar, indeed, that "the intensity of it absorbs the whole mind of the patient, who within an hour from the enjoyment of perfect health expresses his serious and decided conviction that if the pain be not speedily alleviated he must die" (Poland). Vomiting is a constant symptom, first of the contents of the stomach, and often afterward of blood; collapse, rigor, and syncope are often met with.

Incomplete rupture of the coats of the stomach is found sometimes after death, and in Guy's Museum (Prep. 1817[25]) there is the stomach of a child æt. 7 in which, from a sudden blow upon the distended viscus, the mucous membrane was detached and lacerated in a remarkable manner.

Rupture of the intestines, both large and small, is a somewhat common form of abdominal injury, and may be produced by a fall, a blow, the passage of a wheel over the abdomen, or even violent muscular exertion. Hennen (*Military Surgery*) gives a case where a soldier received a contusion of the abdomen, and sloughing of the integument followed with artificial anus, yet in six months the feces resumed their natural course and a recovery took place. In Guy's Museum there is a specimen (Prep. 1851[85]) of perforation of the small intestines of a man who had received a kick from a horse and died thirteen days after the accident with extensive peritonitis from fecal effusion. Prep. 1851[86] consists of a portion of jejunum taken from a man who had been kicked in the abdomen, the injury being quickly followed by symptoms of extravasation and death in forty-eight hours; Prep. 1850[88] was taken from a case of perforation of small intestine from the kick of a horse, terminating in death in twenty-four hours; No. 1851[89] is a portion of jejunum in which are two openings through which the mucous membrane is inverted and resulting from a kick in the abdomen; No. 1851[91] is an example of laceration of the jejunum in which the bowel is completely divided. It was taken from a man æt. 37 who had been run over by a cart and lived twenty-four hours. Lastly, the specimen marked 1851[87] is from a case that occurred in the practice of my father, the late Mr. T. E. Bryant of Kennington, and is a portion of ileum in the coats of which there is a small perforation, the injury being produced by running against a post, and followed by collapse, from which the patient did not rally, but died on the third day.

Cases are also on record in which, after injury, a portion of intestine has sloughed and subsequently passed per rectum, a recovery taking place. In the anatomical museum of the University of Edinburgh several such preparations exist.

The duodenum is rarely ruptured, its position protecting it; nevertheless, such an accident does occur. Taylor, in his *Medical Jurisprudence*, gives a case where a boy æt. 13, after a blow on the abdomen, walked a mile with but little assistance; and when he died (thirteen hours after the accident), the duodenum was found to be completely torn across. In a case of my own a man æt. 25 walked into Guy's after an abdominal injury. He lived thirty-six hours, and after death his duodenum was found ruptured.

The jejunum is doubtless more frequently ruptured than any other part of the intestines, its fixed position rendering it liable to be torn away from the duodenum by such an injury as the passage of a wheel over the abdomen. Poland gives fourteen examples of this kind, and in half of these the laceration was at its upper part. In one case, after death, three or four pints of thin pink-colored fluid were found in the abdomen—probably the iced water of which he had freely partaken after the accident—and in all death took place from collapse and peritonitis. A man æt. 40 received a kick on the abdomen from a horse. He walked to the hospital, but did not appear to be very ill. He was admitted for precautionary reasons. He died suddenly in thirty-six hours, and after death fecal extravasation was found, and a perforation in the jejunum three feet from the duodenum.

The ileum is also frequently ruptured, and most commonly from a direct blow or fall on a hard body. In the majority of such cases there is no external mark of injury, and fecal effusion with peritonitis is the usual cause of death. When the rupture is large, little hope exists of a recovery; when small, such a hope, however, may be entertained. In these cases death is usually rapid; in the following case, however, of a man æt. 21 who was run over and vomited, death did not take place for eighteen days. It followed an action of the bowels, and after death a coil of intestine three feet from the cæcum was found lacerated and adherent.

When a patient is the **subject of hernia** and receives a blow upon the tumor, a ruptured intestine may doubtless take place. Aston Key made this the subject of a memoir in the *Guy's Reps.* for 1842, and Poland has collected many such cases in the same periodical for 1858. Rupture of the gut is the usual result of such an accident; and when it occurs, a fatal termination is to be expected. When the bowel is only bruised, however, it may recover or slough and be followed by an artificial anus.

In none of these cases, when symptoms of inflammation or of injury are severe, should any attempt at reduction be made. The surgeon should, however, explore the sac. In all recorded cases where the bowel has been returned a fatal result took place.

The large intestine is rarely ruptured from violence. When over-distended from fecal accumulation the result of stricture or otherwise, such a result may ensue, but under ordinary circumstances it is too well protected. I have, however, known florid blood to flow from the bowel after an abdominal contusion, and have from that fact suspected laceration of the colon.

TREATMENT.—The chief point to insist on is the absolute necessity of treating *every case* of injury to the abdomen with excessive caution, as very severe mischief may be caused by violence and yet the immediate symptoms not be marked. Collapse after the injury, as has been shown, is by no means a necessary consequence; for rupture of the intestine itself may take place without exciting such a condition, and a patient may walk after having ruptured liver or intestine. The surgeon, therefore, should be guarded in his prognosis as well as careful, watchful, and expectant in treatment.

Collapse, when present, unless it threatens to be fatal, should be disregarded, since it may have a most beneficial influence in checking or preventing bleeding.

In every case absolute rest in the horizontal position should be secured and maintained. If the injury be slight, convalescence will soon be established by such treatment; if severe, secondary bad results may be prevented, and, at any rate, be relieved. The application of cold to the injured part gives comfort, and by checking the circulation does good. A Leiter's metallic coil (Fig. 9) is the nicest mode of applying it, or an ice poultice or bag when the coil cannot be obtained. In some cases fomentations or cataplasms give greater comfort. In exceptional cases, when local pain from peritonitis is great, the application of twenty or thirty leeches gives relief. Opium should always be given in small and repeated doses, such as one grain every four or six hours for an adult. It allays pain, assists, by checking peristalsis, in maintaining rest to the injured peritoneum and viscera, and tends materially to arrest inflammatory action.

The patient should be kept free from all excitement and as little nourishment administered by the mouth as will suffice to sustain life; if the intestines are believed to have been ruptured, *starvation* treatment must be carried out. Whatever is given should be liquid and cold. Milk and ice in limited quantities make the best and simplest combination, and upon this life can be sustained without difficulty. If great thirst exists, ice may be given; but this must be given with caution, as the case already quoted well illustrates. When the intestine is believed to be injured, the allowance of food must be very scanty, the patient's powers being kept alive by enemata of beef tea administered in small quantities, say three or four ounces repeated every four or six hours.

On no account ought a purgative to be administered. This rule is golden in these cases and should never be deviated from, as by infringing it in a careless moment the whole of nature's processes in repairing the injury may be undone and irreparable mischief follow. Constipation is the sign of a passive condition of bowel to the preservation of which all our treatment is directed; a purgative is merely an irritant and in its effects in these cases absolutely destructive.

In all cases the prognosis and treatment should be most guarded, cautious, and expectant, and in all the *state of the bladder* should be well attended to, for retention of urine from disturbed nerve influence is a common accompaniment and must not be overlooked. No case of abdominal injury, however trivial, can be pronounced well within a fortnight.

Rupture of the kidney is an accident from which recovery is more common than from any other viscus, and its position in the loins outside the peritoneal cavity is doubtless a sufficient explanation of this fact. When the injury is not very severe and uncomplicated with other injuries, such cases usually do well. It is generally known by an attack of hæmaturia and local pain following the blow on the lumbar region. The hæmaturia may be but slight and passing or not show itself till the second day. It may cease also after the lapse of two or three days, when it is probable that only a contusion of the kidneys had taken place, for in more severe injuries the bleeding may last fifteen

or even more days. At times clots will be passed, assuming the shape of the ureter, and I have before me the notes of some half dozen cases in which these symptoms were present and from which recovery took place. These clots, however, at times give rise to retention of urine by blocking up the urethra. Retraction of the testicle is an occasional symptom, and so is pain in the course of the ureter and along the course of one of the lumbar nerves.

TREATMENT.—The treatment to be pursued in these cases is rest in bed and milk diet. In cases where the bleeding is profuse the tincture of ergot in full doses is a valuable drug, or a grain of the acetate of lead may be given with half a grain of opium three times a day, or gallic acid in ten-grain doses. Opium should always be given with caution.

When the organ is crushed, the injury is likely to be complicated with other mischief, and under such circumstances peritonitis and hemorrhage, singly or combined, generally prove fatal. When the organ is single and becomes injured, a fatal result is also likely to occur. In page 125 of my *Clinical Surgery* I have recorded such a case. When peritonitis exists, opium is of great value; where urinary abscess in the loin follows, as it occasionally does, particularly in gunshot wounds, the surgeon must make a free incision into it on the outer border of the quadratus lumborum muscle.

Rupture of the ureter was first noticed by Stanley in the *Med.-Chir. Trans.*, vol. xxvii., and in the two cases he related a fluctuating tumor formed by the effusion of urine existed in both. Poland, in the *Guy's Rep.* for 1868, has recorded a third case; but beyond these no others are on record. Four cases of wounded ureter are, however, published by Hennen (*Mil. Surg.*). In all these cases, it seems, the ureter was ruptured by stretching, its renal end having suffered; and I have seen two of these which occurred in the practice of my colleague, Mr. Howse.

The symptoms are very obscure, particularly where no external wound exists; indeed, there are none to indicate the nature of the accident in its early stage. At a later period a lumbar tumor may appear, of a cystic nature, caused by the retention of the secreted urine, and there may be more or less peritonitis. When a lumbar swelling exists, tapping the cavity should be performed, the operation being repeated from time to time as the fluid re-collects, the kidney in time probably ceasing to secrete. When this treatment fails, there is little doubt that a free opening into it in the loin is the correct treatment. Nephrectomy may be required. Under other circumstances the case must be treated as all others of abdominal injury, by rest and opium.

Mr. Holmes records in the *Med.-Chir. Trans.* for 1877, vol. xlii., an interesting case of wound of the ureter which occurred in a boy æt. 13 where a clasp-knife had entered his body from behind, upward and outward, just on the right of the middle line and about on the level of the posterior superior spine of the ilium. The wound discharged urine for two weeks and then closed, the boy recovering.

Rupture of the gall-bladder has been recorded as the result of accident; and when it occurs death is usually rapid. The accident is marked by extreme collapse and pain in the seat of injury. Poland in his Fothergillian prize essay, has given us such a case, and Dr. Fergus, in the *Med.-Chir. Trans.*, vol. xxxi., has recorded another. In one the death occurred from collapse, and in the other from peritonitis.

Rupture of the hepatic duct may also occur. In Poland's Fothergillian essay such an instance is recorded, and occurred in a boy as the result of a blow on the abdomen, the accident being quickly fatal. My friend Dr. Sutton has kindly given me the details of a second case, which took place in the London Hospital in 1867. It was in that of a man æt. 29 who was knocked down, and the wheel of a spring-dray passed over his stomach. He felt pain in the right hypochondriac region directly and "had hard work to get his breath." Abdominal pain increased and jaundice appeared, and for a month he kept his bed. On the thirtieth day after the accident, as he did not improve, he was admitted into the London Hospital under Drs. Herbert Davies and Sutton. Then he had abdominal pain, tenderness, and distension. There were distinct ascitic fluctuation over the abdomen and deep jaundice. He sank eight days after his admission and thirty-eight days after the accident. The autopsy revealed the fact that the hepatic duct was torn across a quarter of an inch above the spot where the cystic joins the common duct; no other part of the liver was injured. The abdominal cavity contained quarts of olive-green bile-stained fluid, and the peritoneum was covered with yellow matter of the color and consistence of paint, which was found to be inspissated bile.

Rupture of the urinary bladder may occur with or without fracture or dislocation of the pelvis. It is usually, but not always, due to external violence applied to a

distended organ. As a rule, the rupture takes place at its posterior wall, the urine escaping into the peritoneal cavity and rapidly causing death. In exceptional cases it affects the anterior wall, when the urine infiltrates the cellular tissue of the pelvis. In the former cases the term "*intra*-peritoneal" is applicable; in the latter, "*extra*-peritoneal."

In estimating any suspected case the surgeon should remember that a distended bladder can scarcely escape from an abdominal contusion, when an empty one may elude the greatest violence, and that a bladder partially distended is more likely to be bruised than ruptured by direct external violence or torn when dragged backward.

This accident is more common in men than women in the proportion of five to one, and it occurs chiefly in young adults. The *extra*-peritoneal is far less dangerous than the *intra*-peritoneal rupture, but "the accompaniments of fracture and dislocation of the pelvis cannot be said," according to Rivington, "of themselves to exercise much influence in the length of the survival."

The bladder generally gives way in its weakest point. The main predisposing condition of rupture is distension of the organ, but this need not be very great. In exceptional cases, as in one recorded by Rivington, the bladder was empty, the undistended viscus being dragged backward with the peritoneum when a cart-wheel passed over the patient's abdomen. The rupture in this case was in front, above the prostate gland.

A second predisposing condition is some obstacle to the exit of urine, urethral or prostatic; and where with this obstacle there is sacculation of the bladder, a very little external violence, or vesical contraction only, brings about a rupture.

In 283 fatal cases collected by Rivington, 224 were brought about by traumatic and 59 by idiopathic causes—that is, in the latter the bladder was ruptured by muscular action combined with overdistension from some obstructive cause such as stricture. I have seen one case of this kind the result of stricture in which the bladder gave way on its anterior or upper wall outside the peritoneum, which got well after free abdominal incision. A rupture from overdistension may be either intra- or extra-peritoneal, according to the condition of the individual bladder. Gross reports that in his cases the peritoneum remained intact in all. The aperture in the bladder when ruptured is not a clean-cut one, but partakes of the characters of a lacerated wound. The edges are more or less jagged and contused, one coat being often torn more than another.

The bladder, as a rule, contracts after rupture, and it is only in exceptional cases that it holds more than a few ounces. There may be much bleeding from the wound, post-mortem records revealing the fact that a large quantity of blood may be found in the peritoneal cavity after death. Mr. Bransby Cooper stated that in his case three or four pints of blood had been poured out.

Symptoms and Diagnosis.—"The typical primary symptoms of rupture, whether traumatic or idiopathic, are a feeling of something giving way, pain, shock, inability to stand or walk, desire, but want of power, to micturate, and removal from the bladder with the catheter of blood only or a small quantity of bloody urine. The deficiency of urine and the loss of power to micturate often continue throughout." These words are those of W. Rivington, taken from a recent monograph on the subject (1884) which merits praise, as it claims close study. In any given case there may be no external signs of injury, though the abdomen may be swollen, prominent, and tender.

Should an attempt be made to pass a catheter, a variable quantity of blood or of blood and urine may be drawn off; and should the catheter by chance pass through the rent in the bladder, the quantity of fluid evacuated may be great. Mr. Durham in one case removed three quarts. The catheter, when in the abdominal cavity, will probably be passed its whole length and be very movable. Indeed, in some cases it has been felt through the abdominal wall. The stream of fluid, when it comes from the peritoneal cavity, is slow and languid; it may be intermittent. As the case progresses symptoms of more or less acute peritonitis develop.

Should the patient survive the accident five or six days, there may be hope of recovery; for repair locally will have gone on, and with it both local and general symptoms will have ameliorated. The bladder will then probably begin to act naturally, pain will have diminished, and the patient will be able to take food. Dr. S. Smith reports (1851) three cases in which the inability to urinate continued, and twelve in which it returned on the second or a later day. In extra-peritoneal cases all the primary symptoms will be more subdued than in the intra-peritoneal, and the secondary symptoms will approach those of extravasation of urine elsewhere, such as diffused cellulitis locally and those of blood poisoning constitutionally.

Treatment.—Up to the present time no definite line of treatment has been laid down,

and as a consequence the results of treatment have been most disastrous. Out of more than two hundred cases tabulated by Rivington, but eight have been recorded as examples of recovery, and it must be added that in them the evidence of their belonging to the *intra*-peritoneal group is not unimpeachable. Still, a careful examination of the evidence afforded by these and other examples is encouraging, and enough to support a line of treatment which is based upon a principle and upon lines which may bring about a good result.

The treatment, to be successful, must be local; general treatment by itself has been proved to be absolutely useless.

The indications for local treatment are—*firstly*, to withdraw the extravasated urine from the peritoneal cavity; and *secondly*, to secure a free exit for fresh urine as secreted.

To carry out the first when the diagnosis is clear, laparotomy should be performed by an incision two or three inches in length made above the pubes, through which the peritoneal cavity should be well cleared of all blood and urine and sponged dry with antiseptic sponges. The rent in the bladder should be closely stitched by a silk suture like that of Lembert's for the intestine (Fig. 282, page 494), and to facilitate this step I would suggest the use of the rectal inflator as described and illustrated (Fig. 363), since by its use the base of the bladder and prostate will be raised out of the pelvis and well into view, thus facilitating manipulation.

After this operation and the abdominal wound has been carefully stitched up, cystotomy should be performed for drainage purposes.

Should, however, much difficulty be experienced in suturing the vesical wound, the surgeon may find comfort in the result of Dr. Walter's case (*Ranking's Abstract*, 1862), in which laparotomy was performed, the abdominal cavity was cleaned, and a rent two inches long seen in the fundus of the bladder left alone, the bladder being, subsequent to the operation, relieved by catheterism, and recovery took place.

When the diagnosis is not sure, the treatment above advised rejected, or the case is late for treatment, a drain for the urine should be made by lateral cystotomy, after which the urine will flow away as secreted. Median cystotomy with the introduction of a tube within the neck of the bladder is likewise good practice, but it does not satisfy the requirements of the case so well as the lateral.

When a catheter has been passed *per urethram* into the bladder, and probably through the rent into the peritoneal cavity, a free irrigation of the cavity should be employed. Mr. Thorp's case (*Dublin Quart. Journal*, vol. xvi.), so far as it goes, tends to support this practice, and Mr. C. Heath strongly advises it.

In extra-peritoneal rupture and urinary extravasation, supra-pubic, and possibly perineal, incisions may be called for and a free vent for secreted urine provided by lateral or median cystotomy.

The probabilities of obtaining a successful result in any of these cases turns, however, more upon the time that has elapsed when they are put into execution than anything else, fresh urine not being nearly so irritating to a healthy surface as urine undergoing septic changes; and these, when once begun, go on rapidly. In Walter's successful cases the operation of laparotomy was performed ten hours after the extravasation; in Willet's and Heath's, unsuccessful, thirty and forty-two hours respectively.

"The records," writes Rivington, "appear strongly to indicate the necessity of bold action. The chances of recovery entirely hinge upon the promptitude of the surgeon adopting efficient measures. In doubtful cases an exploration with the finger through a perineal incision would be perfectly justifiable and could scarcely introduce any fresh element of danger. If the diagnosis of intra-peritoneal rent be clear at the outset, the urine cannot too soon be evacuated by a supra-pubic incision and the peritoneal cavity carefully cleansed. At the same time, a perineal opening may be made with advantage. I am disposed to think sewing up the rent in the bladder unnecessary, provided a free perineal exit be secured for all urine secreted after laparotomy."

The only general treatment should be the administration of opium, a grain of the solid or its equivalent of liquid being given every four or six hours, to allay pain and relieve peristalsis.

Food of a simple character should be given all through.

Injury to the uterus, when large from pregnancy, deserves a passing notice, for such cases are serious. A contused organ may inflame and be followed by abortion or miscarriage, or, should pregnancy continue, its structure may be so altered as to be liable to rupture. In obstetric works cases are recorded in which this accident happened. I have known also an intra-uterine fracture of a child's thigh to take place as a consequence of a fall.

Rupture of an ovarian cyst from a blow is also recorded, and under certain circumstances a good result may take place; all obstetricians have met with such cases. The removal of the ruptured cyst is probably the best practice to be followed, since, if left, a fatal peritonitis generally follows.

Rupture of the diaphragm occurs in practice, but it is an accident difficult to diagnose. It is generally the consequence of some violent injury, such as a crush or the passage of a heavy wheel over the waist. In such cases the injury is complicated, and usually with hernia of the abdominal contents into the thorax. This injury can occur only on the left side. Dr. Wilks, in the *Lancet* for 1858, reported three instances of this diaphragmatic hernia, and pointed out that *excessive thirst* was the most prominent symptom in each. I had the opportunity of seeing these three cases, and others since have come under my notice in which this symptom of insatiable thirst was most characteristic.

Wounds of the Abdomen involving Parietes and Viscera.

The parietes of the abdomen are often wounded by sharp substances, whether by accident or design; and so long as the wounds are confined to the parietes, the danger is small. When the peritoneum is punctured or perforated, the viscera are also probably involved: and under such circumstances the case becomes serious. In rarer instances the intestines protrude, when an additional element of danger is added.

Wounds of the parietes alone require the same treatment as wounds of any other part. The surface should be well cleansed and all foreign bodies removed. Hemorrhage should be arrested by torsion or ligature and the edges of the wound brought together with sutures. In deep or lacerated wounds, where the muscles are involved and the risk of suppuration great, absolute rest in the horizontal position should be enjoined. When suppuration appears, the surgeon must be careful to let out all fluid, either by reopening the wound or by a fresh opening. *All punctured wounds should be left open;* when bleeding persists, the wound should be enlarged and the vessel secured.

Penetrating Wounds of the Parietes.—There is always a difficulty in diagnosing these cases—that is, in making out the true nature of the accident, more particularly in punctured wounds. When the depth of the wound is known by the extent of insertion of the offending body and the relative position of the viscera at the wounded spot also, some notion as to its nature may be formed; but when no such guides can be found, the surgeon has to rest upon surmise and probabilities. As a rule, where want of evidence is felt, it is well to treat the case as serious. All penetrating wounds are serious, whether incised, lacerated, punctured, or gunshot; but punctured wounds are by far the most common.

When there is a total absence of all symptoms beyond those of the parietal wound, the viscera are probably *uninjured, these negative symptoms affording the best positive evidence of the simple nature of the accident.* When the viscera are *injured*, there will generally be more or less lasting syncope or collapse; there will probably be severe local pain, soon becoming radiating; there will also frequently be vomiting, possibly of blood, or the passing of blood from the bowel or bladder. If life is prolonged, there will be peritonitis. When the bowel or omentum protrudes, when the feces, bile, urine, or blood appear at the wound, the evidence is clear. The surgeon, however, will find much help from collateral evidence in forming an opinion—as, for instance, in the size of the wound compared with the instrument that inflicted it, the position of the blood-stain on the instrument, the force with which the blow was struck, the direction of the force in relation to the position of the patient, and the thickness of the abdominal parietes. By these several means an approximate opinion may be formed, but in no case can a positive diagnosis be made with certainty.

Under all circumstances, however, the TREATMENT must be the same. Absolute rest in the horizontal posture, with the legs flexed to relax the abdominal muscles, is essential; no movement should be allowed, not even for passing the evacuations. With respect to LOCAL TREATMENT, the greatest simplicity should be employed. The wound should be cleansed and all bleeding vessels secured, but anything like an exploration of the wound is to be condemned. All probing, fingering, or manipulating the wound should be avoided as dangerous and only pertaining to surgical curiosity. The edges of the wound, when it is large, should be brought together by sutures and some simple antiseptic dressings applied, with cold by the metallic coil. Punctured wounds, when perforating, like others, should be left open. Even after the lapse of some days, when no symptoms of wounded viscera appear, the same caution should be observed, two or three weeks being always

allowed before freedom is given. Under all circumstances the condition of the *bladder* should be inquired into.

Opium in moderate or full doses, according to circumstances, is demanded, to keep the bowels quiet and check peristalsis, it being well to keep a patient under its influence for several days by giving one grain every four or six hours. *Low* diet—that is, milk diet—should be allowed, all food being given cold and in small quantities; ice to suck is refreshing. *Purgatives* should on no account be given till the nature of the case is declared.

Penetrating Wounds with Protruding Viscera.

It is hardly necessary to remark that the special risk of any of these cases is determined greatly by the viscus that is involved and the amount of injury it has sustained. Thus, a penetrating abdominal wound with protruding omentum is far less dangerous than when hernia of the intestines exists, and a protruding wounded bowel is of graver importance than an uninjured one. It is consequently necessary for the surgeon in all these cases mentally to run over the position of the viscera, in order that he may form an opinion as to the probabilities of the case. Fig. 281 will refresh his memory on these points.

"Of the hollow viscera any portion of the intestinal canal may be protruded, from the stomach to the sigmoid flexure, according to the situation and degree of distension of the viscera, the small intestines most frequently, next the large, then the stomach, and, lastly, the cæcum. Of the solid viscera the omentum is by far the most common, and is often associated with that of the viscera" (Poland's prize essay).

In *small* wounds a limited hernia of the abdominal contents can alone take place; but when it occurs, the protruded viscus is very liable to be strangulated. In *large* wounds the hernia will probably be of greater extent, but their constriction is rare.

Fig. 281.

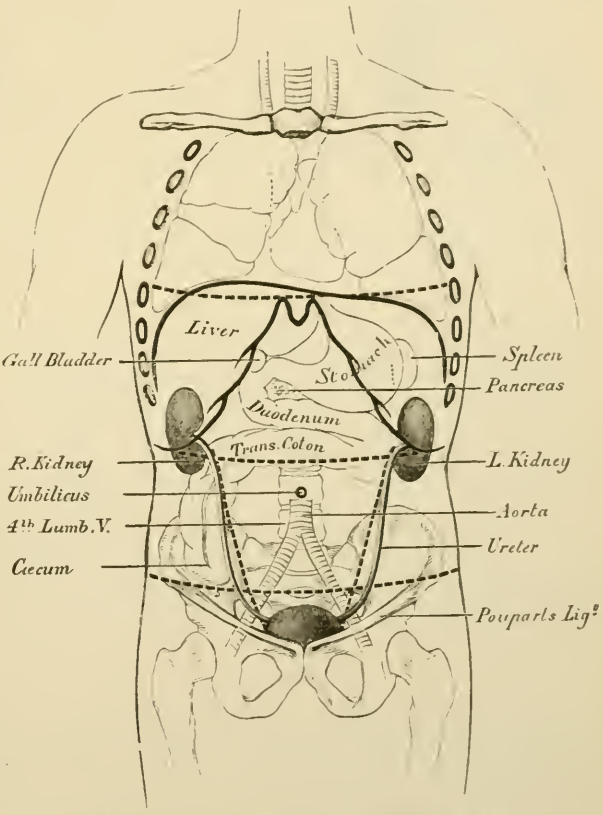


Diagram showing the Positions of the Abdominal Viscera.

When the omentum protrudes through a *recent* wound, and uninjured, it should be washed by means of a stream of antiseptic water and returned with all gentleness, the patient being placed in such a position as to relax the injured muscles. The wound should never be enlarged to allow of the return of the omentum. When the omentum has been extruding for some time and is congested from incarceration or strangulation, when it has become inflamed, or perhaps sloughing, it is well not to make any attempt at its reduction. As time goes on and the projecting mass swells and granulates it may be ligatured in halves. This should not be done, however, for at least two weeks after its protrusion. During this time the greatest quiet should be enforced and moderate doses of opium given with liquid food. After a few days all fear of peritonitis will have passed. Some prefer not to interfere with the protrusion, in the belief that it will wither up sooner or later, but such a process is tedious; the application of a ligature to it in halves is, moreover, rarely attended with any risk. If the omentum is much bruised or torn at the time of injury, such injured portions may be cut off and all divided vessels secured.

When the bowel protrudes through the wound and is *uninjured*, it should be cleansed and *returned under all circumstances*, the wound being carefully enlarged for the purpose in the course of the muscular fibres should its reduction be otherwise impossible. To facilitate this the muscle should be relaxed and the parts last descended returned first. In returning the intestine the pressure should be directly backward; if made obliquely, the bowel might be pushed up beneath the fascia or muscles, and thus outside the peritoneum. The wound should be closed by sutures and treated as already described.

When the protruded bowel is *gangrenous*, it must be left *in sitû* to slough and that an artificial anus may form, the wound in the abdominal parietes being enlarged, but where there is any prospect of its recovery the abdominal cavity is its best place.

When the intestine is wounded and the opening a mere prick through which no intestinal contents exude, the bowel may be returned, a few hours being enough for the wounded part to become sealed by plastic exudation and repair to be completed.

FIG. 282.

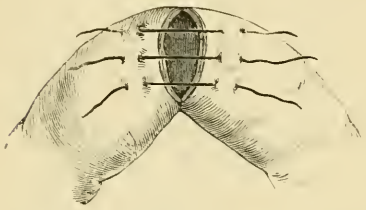


FIG. 283.

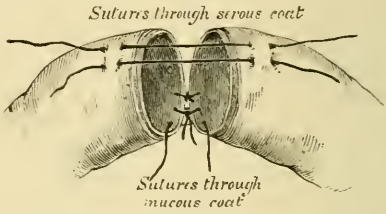


FIG. 282.—Lembert's Suture, including Peritoneal Coat alone.
FIG. 283.—Double Suture. 1. Of mucous and muscular coats. 2. Of serous, as in Lembert's. (In distal side of bowel the serous suture should precede the mucous; in proximal, the mucous suture should be applied first.)

When the mucous lining protrudes, the opening should be tied by a single fine ligature. When the wound is sufficiently *large to permit of the escape of the visceral contents*, it must be stitched up with the form of suture seen in Fig. 282 or 283, cleaned, and returned, the ends of the sutures being cut off close.

When the wound *involves nearly the whole calibre of the bowel* and the bowel is much bruised or injured, it is wiser to stitch the edges of the bowel to those of the wound, thereby making an artificial anus, than to stitch the two divided ends of the intestine together, and to return the whole into the abdominal cavity, although, says Pollock, if the division be caused by a clean sharp instrument, the extremities may be brought together by sutures and returned; but if the separation be the result of an irregular lacerated wound, as from gunshot, etc., we should not hesitate to fix the edges to the external wound and risk the chance of an artificial anus. When the bowel is stitched to the edges of the external wound, care should be taken to maintain the line of the canal as much as possible, and not to draw the intestine more out of its position than is absolutely necessary.

The general and local treatment of all these cases is similar to that already laid down for the treatment of other abdominal and visceral injuries.

Penetrating abdominal wounds complicated with wounds of the viscera, but without protrusion, are, doubtless, far more serious than any that have been hitherto considered; and their effects depend greatly on the condition of the viscus when wounded. Thus, the puncture of a *distended* stomach, intestine, or bladder will to a certainty be followed by extravasation into the abdominal cavity, and, as a result, by great shock and diffuse peritonitis; whereas these organs, when empty, and therefore contracted, may receive a limited injury without any such consequences taking place. *local* inflammation rapidly arising under these circumstances and sealing the wound.

The chief risks of wounds of the viscera when the solid organs become implicated are hemorrhage; and when the hollow, extravasation. When the contents of the wounded organ escape externally through the wound, the danger of the case is undoubtedly lessened. When the *stomach* is supposed to be wounded by a puncture, the utmost care is called for to prevent the administration of any food; indeed, *nothing* should enter the stomach for several days, and life should be maintained by nutrient enemata, because to excite any action of the organ would undo what nature may have done for the repair of the injury, and thus jeopardize life by increasing the risk of extravasation. When the *intestine* is *wounded* or suspected to have been wounded, the same care is necessary. When the bladder is wounded, it should be drained by lateral cystotomy.

Opium should be given, and is best administered by suppositories, the morphia suppositories of the Pharmacopœia being the best preparation to employ in all cases of abdominal surgery. The principles of treatment, however, are the same as have been laid down in former pages. In marked penetrating wounds of the abdomen in which evidence of a wounded hollow viscus exists, the *local wound*, as generally advised, *should be left open*, or covered only with a loose covering; for to close the wound so as to prevent the escape of the contents of the wounded viscus externally would be to close the only gate through which return to health is possible. I am, however, disposed to think that the wisest course would be to enlarge the wound or reopen the abdominal cavity, search for the wounded viscus, and sew up the opening in it, subsequently cleansing the abdominal cavity and dealing with the case as described in a former page, the chances of a good result being far greater by this practice under the circumstances than they can by any other.

Remarkable cases of recovery after impalement are on record, and not the least is that of a boy æt. 11 who fell upon a rick stake, the stake penetrating his body for seventeen and a half inches. It entered the abdominal cavity in the *right* groin, beneath Poupart's ligament, passed through it to the left side into the thorax, through the diaphragm—displacing the heart and pushing it to the right side of the sternum—into the left lung, and passed out of the chest, between the seventh and eighth ribs, into the axillary space. The stake was removed four hours after its introduction, and not a teaspoonful of blood was lost. Some intestine which protruded from the wound in the groin was replaced and the inguinal wound stitched up. Opium, with calomel, was freely given subsequently, and in six weeks the boy was able to sit up, play, and eat his ordinary food. Five months after the accident he was free from pain and able to walk freely. The case occurred in the practice of Mr. Reynolds of Thame, Oxon, and is recorded in the *Med. Times and Gaz.*, September 23, 1871.

Abnormal Anus, Fecal Fistula.

Confining the term *artificial anus* to the surgical operation of forming an anus otherwise than natural for the relief of intestinal obstruction, whether by colotomy or enterotomy, and *abnormal anus*, or intestinal fistula—*fecal fistula*—or an unnatural communication between the intestinal canal and the outside of the body, is generally the result of sloughing or ulcerating bowel in strangulated hernia, although it may occur either from a wound to the intestine from some external cause, or from a perforation of the intestine from an ulcerating process originating from within.

When it follows a hernia, the opening is usually at the neck of the hernial sac; when it follows a wound, at the seat of injury; when it is the result of some ulcerative process originating from within, the fecal abscess may burrow into the pelvis (opening into the vagina, bladder, or even bowel again), or between the abdominal muscles, and make its appearance in the groin, iliac fossa, or loin. When the opening is *large* and *direct* into the bowel, it has been called "artificial anus;" when small, indirect, or fistulous, "fecal or intestinal fistula."

The most important point, however, connected with this subject has reference to the amount of intestine involved. When only a small portion of its calibre has been lost, the fistula generally will be small; when a large portion of its calibre or a whole knuckle has been involved, the fecal orifice will be large. Under these circumstances, the two orifices communicating with the upper and lower ends of the bowel respectively can generally be made out, a fold of membrane formed by the junction of the bent tube standing as a partition between the two portions of the gut. At times this partition will project so far forward as to close completely the orifice of the lower part of the bowel, and this is the usual state of affairs when a complete knuckle of bowel has been involved in the disease and under these circumstances a cure by natural processes is almost impossible. At other times the partition will be but limited and a portion only of the contents of the bowel will pass externally, the other portion taking its normal course downward toward the anus, when it is more than probable that nature alone or but slightly assisted by art will effect a cure. When the orifice is large, there is almost always some prolapse of the bowel. Under all these conditions the intestines within the abdomen are closely connected by means of adhesions to the external orifice, the serous surface of the intestine becoming firmly fixed to that of the opening in the abdominal parietes. Beyond these adhesions it is rare to find other coils of intestine adherent about the part; on the contrary, the parts are otherwise usually so free that coils of bowel will be found separating the two portions of intestine that are adherent at the wound, and may so dip down between them

as to push forward a serous sac into the artificial opening, and even to form a hernia. The nature of the discharging fluid will fairly indicate the portion of the bowel involved: when well-formed feces pass, the large or lower part of the small intestine is probably the seat; when the fluid is thin and inoffensive, the jejunum is indicated.

Prognosis.—The yellow semi-feculent contents of the ileum can generally be recognized. The nearer the opening is to the stomach, the worse is the prognosis, as nutrition under such circumstances must be seriously interfered with. The nearer it is to the lower end of the canal, the better are the prospects of life.

Treatment.—When the orifice is fistulous and the canal below the fistula is fairly open for the passage of feces a cure may with some certainty be looked for by natural processes; and such a result is by no means unusual in the artificial anus, which is met with *after the return of a small hernia into the abdomen*, and particularly of a femoral hernia. In these cases the surgeon has little more to do than to keep up the strength, give simple nutritious diet, maintain perfect cleanliness of the wound, and apply gentle pressure to the part. When the fistulous communication is larger, the same treatment must be employed, though with less hope of success. Lawrence recommended the constant use of a truss in these cases to prevent prolapsus, and Pollock strongly advocates the importance of the recommendation, adding that "a compress of linen placed on the opening, with a larger pad over it, and a truss applied over the whole, will in a great measure restrain the contents as well as prevent the protrusion of the bowel." To assist the contraction of small fistulæ the edges may be cauterized, or even pared, a plastic operation being justifiable under certain circumstances.

With respect to surgical interference in these cases, the recommendations I have to offer are not very satisfactory. Dupuytren[1] suggested an operation to get rid of the projecting fold or septum that has been described. He did this by an instrument called an enterotome, a pair of forceps with one blade grooved, into which the other closed, the approximation of the blades being regulated by a screw. The septum was crushed between the blades, and so held till its destruction was effected. The instrument, as a rule, came away about the seventh day, and, Dupuytren says, "by the division and loss of substance the ridge and the double septum which separate the two ends of the bowel are destroyed, so as to re-establish the interrupted communication between them and restore the natural course of the aliment and feces." Jobert advises the pressure of the instrument to be gradual, fatal cases having occurred when Dupuytren's rapid process has been employed. The theory of this operation is good, and is based on nature's own processes; for I have seen the septum of an artificial anus ulcerated through by natural processes, leaving an opening through which feces passed from the upper to the lower bowel, a narrow band above alone existing to prevent a freer feculent flow. The success of the operation has also been good, inasmuch as out of forty-one operations recorded by Dupuytren twenty-nine recovered, nine were relieved, and three died. In this country the operation has been little practised. Dr. Buchanan of Glasgow, however, has recorded a successful case (*Edin. Med. Journ.*, 1869).

When a *fecal abscess* has formed in the abdominal walls, the sooner it is opened, the better; and when opened, the incision should be free. In abscesses connected with the *cæcum* or its *appendage* this rule is important; and if acted upon, good results may be anticipated. For intestinal fistula opening directly into the *vagina* little can be done surgically beyond attending to the general condition of the patient, giving nutritious food, though not such as is likely to distend the bowel, and observing perfect cleanliness of the passage. The external opening should be enlarged, however, if anything like retained pus exist. Under these circumstances a natural recovery may take place. In recto-vaginal fistulæ plastic operations are most successful.

When the *bowel* has ulcerated into the bladder, natural processes appear to be rarely capable of effecting a cure; and under such circumstances, to save the patient from the miseries caused by the passage of solid feces into the bladder, the operation of colotomy may be entertained. I have performed this operation on many occasions under these circumstances with success, the operation in all giving great relief. One of my patients is now (1884) alive, free from all pain, the operation having been performed on July 5, 1870 (*Clin. Soc.*, 1872). In another case, operated upon on August 16, 1869, the gentleman lived to March, 1875, and died from heart disease at the age of seventy. The third died from some kidney affection some months after the operation (*Med.-Chir. Rev.*, 1869). The others died some weeks after, from the cancerous affection for which the operation was demanded, but free from all pain.

[1] *Mém. de l'Acad. de Méd.*, 1828.

Foreign Bodies in the Stomach and Intestines.

Foreign bodies are often taken into the stomach from accident and design, and the records of cases prove that from the absence or mildness of symptoms no surgeon should pronounce against the possibility of their introduction. They are passed as often as not *per anum* without giving rise to very distressing symptoms, although when retained they cause nothing but evil. *Smooth hard bodies*, such as coins and stones, as a rule, pass readily without giving rise to any, or other than slight colicky, symptoms; but *sharp* and *pointed bodies*, such as bones, pins, knives, metallic plates with teeth, etc., give rise to such as vary according to the position of the intestines at which they become impacted.

A foreign body taken into the stomach may be ejected by vomiting, discharged externally through the abdominal parietes, retained in the stomach, or passed onward. In Fig. 284 is illustrated a piece of iron wire that was swallowed by a female lunatic æt. 56

Fig. 284.

Piece of Iron Wire Discharged from Abscess in Abdominal Walls after having been Swallowed. (Natural size.)

on March 10, 1873. The symptoms that followed were so slight that some doubts as to the occurrence existed, and it was not till May 15, two months later, when a swelling was detected in the right of the umbilicus, that the history was credited. The swelling rapidly increased, and opened on May 20, and the point of the iron wire projected. This was withdrawn by Dr. T. B. Dyer, the surgeon of Colney Hatch, and a rapid recovery followed, no single bad symptom making its appearance. My friend Mr. Lund of Manchester has likewise recorded a similar case in the *Liverpool and Manchester Med.-Surg. Reports* for 1873. When retained, a foreign body may rest without giving rise to very serious symptoms—a rare result—or set up ulceration, which may in its turn give rise to a fatal peritonitis. In the more fortunate it will be passed on through the canal and discharged.

To prove these points I may record the case of a man æt. 22 who came under my care in 1882, two days after having swallowed, in the night, an artificial metal plate, two inches long by one wide, with three incisor teeth, and metal hooks to catch the right two and left first bicuspid teeth (Fig. 285). He passed the plate *per anum* without pain, on the eighth day, and restored it to its original position, and was no way injured by its passage. The reader may also refer to Mr. Pollock's article in *Holmes's System*, vol. i., where he gives a case in which a lady vomited a gold plate three-quarters of an inch long, with two false teeth, after it had been lodged in the œsophagus for nineteen and in the stomach for ninety-seven days. A case is likewise on record in which a lady passed *per anum* a plate two and a quarter inches in diameter, with four teeth, six months after she had swallowed it.

Fig. 285.

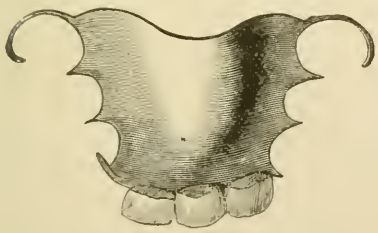


Plate with Teeth passed *per anum* on Eighth Day.

A remarkable case of this kind has been recently recorded in the *Thirtieth Report of the Commissioners in Lunacy*, 1876. A woman æt. 43 (having made previously many suicidal attempts) on July 31, 1875, swallowed thirteen screws, each screw consisting of a body two and a half inches long and half an inch thick, a raised collar nearly two-thirds of an inch in diameter, and a square head, the whole thirteen screws weighing twenty-four ounces. She was fed on pudding and gruel, morphia was injected subcutaneously to relieve pain, and after a few days ounce doses of castor oil were given daily. On the forty-first day the first of the screws passed by the bowel, and by the end of the sixth month the last came away. The screws in their passage had lost four ounces and three-quarters in weight. This case occurred in the Bristol Asylum under the care of Dr. Thompson. Poland has also recorded in his prize essay the case of a lunatic who died from ulceration of the duodenum owing to the pressure of a spoon-handle that had been swallowed about three months before, with *thirty* others, besides nails, pebbles, and pieces of iron. These foreign bodies were extracted from the stomach after death, and weighed in all forty ounces. The most complete list of cases of foreign bodies in the

digestive canal will be found in the *Union Médicale* for November, 1874, by Dr. Mignon.

In Guy's Museum (Prep. 1800) there is an enlarged and thickened stomach of a sailor who had swallowed clasp-knives. He was æt. 23, and in June, 1799, he swallowed four clasp-knives, which were discharged from the bowels. In March, 1805, he swallowed from fifteen to twenty more, after which his health became impaired. He vomited the handle of one and passed portions of the blades of others, and in March, 1809, died in a state of exhaustion. After death one blade was found perforating the colon opposite the kidneys, but without extravasation of feces, and another was fixed across the rectum. In the stomach, too, were numerous blades partially dissolved, or between thirty and forty fragments in all.

At times intestinal calculi form from the agglomeration of hair, husk—particularly oat-husks—or other foreign substances, and prove fatal. Dr. Down has recorded such a case[1] in a boy æt. 13 who died of exhaustion after fifteen days' illness. Not many years ago I saw an artist æt. 36 who died from intestinal obstruction, through whose abdominal walls a globular indurated mass was readily felt on the right of the umbilicus. I suspected it to be made up of hair, for he was in the habit of sucking to an excess the paint-brushes of his pupils; but the diagnosis could not be verified after death.

TREATMENT.—Rest in the horizontal position and expectant treatment are in these cases the two essential points to be observed. Purgatives should on no account be given. The "smasher," according to Pollock, who constantly swallows false coin when caught in the act of passing it, avoids *purgatives*, but takes a constipating diet, such as hard-boiled eggs and cheese, together with his usual food, thinking that the money is more likely to be caught, and consequently passed, in a bulky stool than in a liquid one. The surgeon should act on this principle. When the foreign body becomes impacted in the stomach or intestine or sets up inflammatory action and peritonitis, the abdomen should be opened and the foreign body removed by *gastrotomy*, ten cases out of eleven in which this operation has been performed having recovered. (*Vide* paper by Dr. Pooley of New York, *Richmond Med. Journ.*, April, 1875.)

GASTROTOMY AND GASTROSTOMY.

When the stomach has to be opened for the removal of a foreign body, the operation is rightly described as that of "gastrotomy." When the same operation is performed with a view to establish a permanent fistula for the introduction of food, as first performed by Sédillot in 1849, and described by him as gastro-stomie, the term "gastrostomy," as suggested by Dr. Pooley, seems to be the more applicable term.

That the operation of *gastrotomy* is not necessarily fatal is proved by the fact that it has been performed at least eleven times, and in ten with success; and though in the fifty or sixty cases in which *gastrostomy* has been undertaken for *cancer* life has never been prolonged for more than six months (my own case, *Lancet*, May 6, 1882), the relief it has afforded to those who have been subjected to it is sufficient to prove that it is based upon a sound principle and a humane practice, the operation having been undertaken more with a view of mitigating the horrors of a death from hunger and thirst and of prolonging what remained of life than from any curative object. I have had an opportunity of watching the progress of some of the early cases under the care of my colleagues, Messrs. Cooper Forster and Durham, of many under my own care, and of some under the care of other colleagues, and I am free to acknowledge that the advantages given by the operation are worth the risk, and that if life was not prolonged it was certainly rendered more endurable.

When the operation is performed for a cicatricial stricture, better results may be recorded; for out of eleven cases reported eight recovered. The interesting cases operated upon at Rostock by Dr. Trendelenburg, March 8, 1876 (*Med. Record*, March, 1878), in Paris by M. Verneuil (*Gaz. des Hôp.*, October 28, 1876; *Lancet*, January 13, 1877), and my own case (*Lancet*, April 8, 1881) support this view.

Trendelenburg's case was in a lad who had swallowed some sulphuric acid six months previously, and the stricture was in the lower end of the gullet. At the end of the fifth month after the operation the weight of the boy's body had increased by one-fourth. The boy took food, as usual, by the mouth, masticated it, and then blew the contents of his mouth through a long elastic tube directly from the mouth into the cavity of the stomach.

[1] *Path. Trans.*, 1867.

Verneuil's patient was a mason æt. 17, and the stricture a cicatricial one due to the accidental swallowing of some caustic potash on February 4, 1876. Œsophagotomy was out of the question, as the stricture was situated low down in the tube, and relief was called for because swallowing was impossible. On June 26 gastrostomy, consequently, was performed, and a rapid recovery followed. The man was up and about on August 20. A caoutchouc sound was kept in the wound for feeding purposes. In the report of the case it is stated that when food is poured into the stomach the only sensation experienced is that of heat or cold. Saliva, however, is at the time freely secreted, and the man executes masticatory movements. Digestion goes on well without the aid of saliva.

My own case was a girl æt. 22 who seven months before her admission into Guy's, in July, 1880, had swallowed a wineglassful of sulphuric acid. The œsophagus was almost completely closed, and no bougie could be passed. A rapid recovery followed the operation, and the opening into stomach was very small. The patient is now well, but unable to swallow anything. The opening into the stomach is hardly visible and the parts around it are quite dry. She can feed herself when standing and no regurgitation of food or fluid takes place.

These cases are most satisfactory, and are sufficient to encourage the belief that better success would follow this operation, even when undertaken for cancer, if it were performed at an earlier period of the disease than has hitherto been the practice.

We perform colotomy on a patient with cancerous stricture of the intestine or other mechanical obstruction without hesitation, and surgeons are now willing to admit the great advantages afforded by this means. Surely, the advantages offered by "gastrostomy" for stricture of the œsophagus, cancerous or otherwise, are not less potent; and *should it be undertaken before the patient's powers have been brought to too low an ebb*, there is no reason why it should not be equally effective. In one of my own cases performed for cancer the man lived five days, and the operation had nothing to do with the death, there being no peritonitis, and the local repair was most complete. In the second case the patient lived two days; in the third, fifty-one days; in the fourth, six months. So also was colotomy unsuccessful till it was undertaken at an earlier stage of the disease. Gastrostomy, as a rule, has been put off until too late; it has, however, now become an established operation in surgery.

Operation.—An anæsthetic should be given, although the risks of vomiting as a consequence are not slight. The patient should be placed upon his back and an incision made parallel with and half an inch below the margin of the left ribs. The cut should be from three to four inches in length, and its centre should correspond with the line of the linea semilunaris; the tissues should be divided *seriatim* down to the peritoneum. Every vessel should be twisted or tied as it bleeds, and all capillary oozing arrested by a large sponge. The peritoneum may then be divided and the stomach sought. In the cases I have operated upon it was seized readily. If the liver presents, it should be raised; and if the omentum comes into view, it should be drawn downward. The colon should not be mistaken for the stomach. When the stomach is found, it should be held well forward against the abdominal parietes with a pair of tenaculum pointed forceps and two loops of fine silk introduced, one-third of an inch apart, by means of a delicate curved needle, through the peritoneal and muscular coats of the viscus. The ends of these loops should be left long, for a purpose to be described later on. The stomach may then be carefully secured to the margin of the wound by means of a sufficient number of silk sutures; the sutures should be made to include the peritoneal and muscular coats of the stomach and the parietal layer of peritoneum and muscles. Some surgeons introduce a double row of sutures, but I do not believe this step is necessary.

The first half of the operation is now completed.

The second half is really the completion of the operation, for it includes the opening of the stomach; and this should be carried out on the fifth or sixth day after the first step, and is effected with ease and without pain by simply holding the stomach forward by means of the two loops of ligatures which were introduced into its walls when first caught, and puncturing the exposed area with a tenotomy knife. The opening into the stomach need not be larger than one-eighth of an inch. The silk loops may now be removed. By this small puncture the surgeon gains all he can desire, for the walls of the stomach being elastic, the small opening readily yields to the slightest pressure, so that a tube the size of a No 10 catheter can readily be introduced into the stomach for feeding purposes, and by virtue of this same elasticity, when the tube is withdrawn, the artificial orifice closes, and as a result there is little or no escape of the contents of the stomach to saturate the patient's linen or to irritate the soft parts around the artificial orifice and thus add

to the patient's discomfort. In the case recorded above the wound is now, as it has been since 1880, quite dry.

For feeding purposes after the first few days have passed, and during which warm milk with eggs is the best diet, the food should be thick, and for its easy introduction Messrs. Krohne of 8 Duke street, Manchester Square, have made for me an apparatus which consists of a small Higginson's syringe with a small tube at one end to be introduced into the stomach, and a larger one in the other connected with a glass funnel as a receptacle for food. With this thick food, such as peptonized meat, can easily be thrown into the stomach.

It must be added that Sédillot was the first person to perform the operation in 1849, and Mr. Cooper Forster, on the suggestion of Dr. Habershon, was the first to do it in this country in 1857. Since then it has been repeated about fifty or sixty times.

By way of conclusion, gastrostomy should be undertaken for cancerous or cicatricial stricture of the œsophagus as soon as there is a practical difficulty in the introduction of solid food into the stomach, life being prolonged and much misery saved by such a practice when the disease is cancerous, and life being saved indefinitely when the cause is traumatic.

When the ulceration is not cancerous, but simple or syphilitic, a cure may be looked for, my colleague, Mr. Davies-Colley, having now a patient alive for whom he performed gastrostomy some years ago to save her life from starvation, and nine months later closed the fistula, the ulceration having healed and the power of swallowing having been restored.

The operation should, when practicable, be divided into two steps, as suggested by Mr. Howse, and, his improvement being so great, it should be described as "Howse's operation."

The opening into the stomach should not be larger than that made by an ordinary tenotomy knife, or about one-eighth of an inch.

Intestinal Obstruction.

In cases of acute or chronic intestinal obstruction, when the physician's art has failed to give relief, the surgeon's aid is required; and it would be well for the medical mind to recognize the fact that in a large proportion of instances this aid is sought at too late a period—that is, when the patient's powers have become so exhausted as to exclude all hope of a successful issue being obtained by any treatment, or when the involved tissues have undergone such changes from peritoneal complications as to forbid any reasonable expectation of the competency of nature's reparative powers to effect a cure even where the cause of the obstruction has been removed.

It should ever be remembered that cases of *acute* intestinal obstruction, like those of strangulated hernia, require prompt and active treatment if they are to be successful, and that those of *chronic* obstruction require a no less decided line of action. It must be admitted, also, that there is no class of cases which claim for diagnostic purposes more thought and judgment, that the difficulties of diagnosis as to the cause of the obstruction are sometimes great, and that the question of operative relief has to be decided, consequently, upon uncertain grounds. But such arguments, to my mind, are in favor of operative measures for diagnostic as much as for curative purposes, and in no way tell against them when the diagnosis is clear.

When the diagnosis is clear and the nature of the case decided, delay is dangerous and a want of courage in the surgeon to act upon the diagnosis is criminal. The question of diagnosis is, consequently, all-important and will first claim attention.

Diagnosis.—In a clinical point of view, cases of intestinal obstruction may be divided into *acute* and *chronic*. The *acute* include strangulation of a portion of bowel from external or internal hernia, omental, mesenteric, peritoneal, or fœtal bands, or twists of the intestine (volvulus). The *chronic* embrace inflammatory, syphilitic, or cancerous strictures of the large or small intestine, the occlusion of the bowel from the mechanical pressure of tumors, adhesions of the intestines from inflammatory peritoneal changes, and last, but not least, the impaction of feces.

Perityphlitis, the passage of a gall-stone, and acute peritonitis due to perforation may simulate acute obstruction. Intussusception belongs to both divisions, since, when the invaginated portion of bowel is acutely strangulated, acute symptoms will show themselves; and when the same portion is incarcerated, the symptoms will be chronic, although in their onset they may be sudden. The relative frequency of these conditions will be seen in the following table:

Causes of Intestinal Obstruction, excluding Hernia,

being an analysis of 124 consecutive cases extracted from the post-mortem records of Guy's Hospital by Dr. Hilton Fagge from 1851 to 1868 (*Guy's Rep.*, 1868, and Mr. Russell from 1868 to 1876 (unpublished).

Guy's Cases.

33 Acute obstruction.

- 1 internal hernia.
- 7 twists (volvulus).
- 25 bands
  - 14 lymph.
  - 6 diverticula.
  - 2 appendix cæci.
  - 2 to neck of hernial sac.
  - 1 from pedicle of ovarian tumor.

76 Chronic obstruction

- 3 fecal impaction.
- 3 mechanical pressure of tumors.
- 47 stricture
  - 2 small intestine.
  - 45 large.

Analysis of 63 cases of stricture of intestines as given in a paper by Coupland and Morris (*Brit. Med. Journ.*, January 26, 1878).	Middlesex Cases, 28 large intestines, 3 small.	Pathological Society, 31 large intestines, 1 small.	General Total.
33 rectum and sigmoid flexure	24	21 =	78
7 transverse colon with hepatic and splenic flexures	3	9 =	19
5 cæcum or ileo-cæcal	1	1 =	7
			104

- 23 matting together of intestinal coils from peritoneal and cancerous disease. (Contractions.)

15 Intussusceptions

- 2 rectal.
- 7 ileo-cæcal.
- 6 small intestine.

124

In all cases of intestinal obstruction the diagnosis should be made upon the principle of exclusion, the practitioner coming to a conclusion by first running over every possible cause and eliminating each *seriatim*, and subsequently weighing the points in favor of the probable cause.

The possibility of the symptoms being due to a strangulated or incarcerated external hernia should always be carefully investigated.

Acute Internal Strangulation of the Bowel,

whether from an internal hernia, twist (volvulus), or a fœtal or peritoneal lymph band, may take place at any period of life, and the symptoms to which it gives rise are those of an acute strangulated external hernia—viz., sudden and definite onset of the illness in a healthy subject, severe paroxysmal central abdominal pain, attended by sickness and more or less collapse; constipation, inability to pass wind downward, and hiccough; occasionally, also, scanty urine, or even its suppression; coils of distended bowel are sometimes visible through the parietes.

There will, however, be no distinct abdominal tumor, no tenesmus, and no hemorrhage from the bowel, such as is often present in an acute intussusception. There may, however, be some evidence of one coil of intestine being more tense or distended than another.

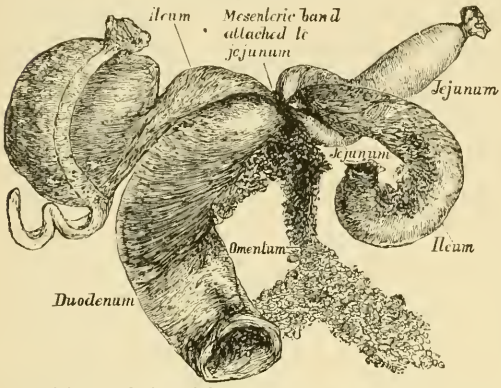
When, therefore, a case presents itself with these symptoms, there can be no difficulty in coming to a conclusion as to its nature, although it may be difficult, if not impossible, to diagnose the precise cause of the strangulation. If, however, we refer to the table above, some guide will be found; for it will there be seen that out of 33 cases 25 were due to bands, 7 to volvulus, and 1 to internal hernia.

When there has been a history of old hernia, the probabilities of the existence of a band are much enhanced, since it is true that with hernia such bands are not uncommon. Duchaussoy in his paper "On Internal Strangulation" (*Mém. de l'Acad. de Méd.*, 1860) gives such cases. Fagge quotes one, and in my own practice four have occurred. One died unrelieved; in the second I opened the empty hernial sac, and so enlarged my incision upward for about two inches as to detect a band high up in the abdomen, which I divided with a pair of scissors, and a perfect recovery took place. This case occurred in the practice of Dr. Wilkinson of Sydenham, and is fully recorded in the *Med.-Chir. Trans.* for 1867. The patient is still alive. The third and fourth died after the operation, but the band was divided and a large coil of intestine released. The operations had been delayed too long.

Mr. Gay's analysis of 148 cases tells us that 102 were in the male and 46 in the female, and that the largest number of cases took place in patients between 15 and 35.

The surgeon under the circumstances related, however, has a clear case and an important decision before him; for if the diagnosis be correct and a portion of bowel is *strangulated* within the abdomen, obstructed by some solitary band, or twisted, he knows that very little can be looked for by medical treatment—that by leaving things alone and the case is unrelieved death is inevitable; and he is aware, moreover, that the hope of a cure by natural processes is very meagre; and if I estimate that hope as being nearly on a par with that entertained in a case of ordinary strangulated hernia when left to itself, I shall probably be about the mark, since cases of strangulated hernia do *occasionally* go up of themselves when all surgical efforts short of herniotomy to reduce them have failed, and cases of internal strangulation, from whatever cause, do *occasionally* free themselves. Nevertheless, no prudent mind, on the strength of these exceptional occurrences, would willingly leave a case of external strangulated hernia to itself; and I think that no prudent surgeon ought to leave unrelieved any case of internal hernia or strangulation to the same almost forlorn hope, because, granting that the diagnosis of the case can be made, by no medicine, no manipulation, no expectant treatment can the mechanical obstruction be overcome, and under these circumstances a fatal termination must be anticipated.

FIG. 286.



Case of Strangulation of the Bowel by Lymph Band constricting Ileum about three inches from Cæcum and a Coil of Jejunum. (Taken from a man æt. 26, who died after bowel obstruction of fifteen days' duration. This case occurred in my father's practice in 1838, and is recorded in *Trans. Med. Soc. of London*, 1846. The suggestion was then made of operative interference.)

Opium may relieve pain, mask symptoms, and give rise to a pleasing delusion that all is doing well in cases of internal strangulation, as it is well known it does in others of external hernia, but in the one as in the other it does no more. It does not accomplish the only true remedy—viz., relieve the mechanical strangulation to which the bowel is subjected.

In *external* acute strangulated hernia the only recognized correct treatment when the hernia cannot be reduced is herniotomy; and when the hernial tumor does not seem to be the seat of strangulation and symptoms of strangulation exist, the surgeon regards an exploratory operation at the seat of hernia for purposes of diagnosis not only a justifiable, but a called-for, measure.

In *internal* hernia, or in any case of acute strangulation from whatever cause, I maintain that a like principle of practice should be acted upon; for when the diagnosis is sure, it is by "laparotomy" alone that a cure can be brought about; and when it is uncertain, it is by "laparotomy" alone that the diagnosis can be made out and a correct line of treatment adopted.

The operation of ovariotomy has proved to us that the exposure and the manipulation of healthy intestine are not of themselves fatal measures, and there is every reason to believe that in the cases now under consideration a good result might often be secured if the operations were performed before a fatal peritonitis had set in or the strangulated bowel been injured past recovery. At any rate, as matters now stand, a recovery by medical treatment from an internal strangulation is a matter of wonder, and it would be well, as all collateral experience indicates, that a bolder practice should be employed.

If we appeal to pathology—and it is only there, unfortunately, that we can appeal—we receive ample facts, since the late Dr. Fagge, in his able article already referred to, tells us that "there might in many cases have been no little difficulty in finding a band among the distended coils; but I regard the facts derivable from our post-mortem records as indicating no insurmountable obstacles to the success of an exploratory operation in the great majority of the cases of true internal strangulation which are to be found in these records." Dr. Brinton, in his analysis of six hundred cases, points also to the same conclusions. Under these circumstances I feel bound to express my conviction that on the diagnosis being made of an internal strangulation, from whatever cause, the operation

of "laparotomy" should be performed, and that on the diagnosis of the cause being uncertain laparotomy is likewise called for to clear up doubts and to deal with conditions which are otherwise irremediable. But this operation is not to be performed as a *dernier ressort* more than that for external hernia, but should be carried out as early in the progress of the case as the diagnosis will justify—when, in spite of the gravity of the measure, good results may be looked for.

A Help to Diagnosis in Cases of Abdominal Obstruction.

"Let no one set too much value on any one sign or symptom."—FAGGE.

	Acute—	Chronic Obstruction.		Acute or Chronic—
	Obstruction or Strangulation.	From Disease of Large Intestine.	From Disease of Small Intestine.	Intussusception.
Previous condition of subject.	In good health.	Ailing for some time with abdominal symptoms.	Ailing with previous attacks of incomplete obstruction.	In good health.
Mode of attack	Very sudden and acute.	Symptoms gradually increasing in severity, or acute grafted upon chronic.	Paroxysms of colicky pain, upon old symptoms.	Sudden onset, and increasing when acute, subsiding when chronic.
Early symptoms:				
Pain.....	*Abdominal pain*, fixed, central, and paroxysmal.	*Pain*, diffused and increasing with distension.	*Pain*, paroxysmal, with intervals of ease in hypogastric situation.	*Pain*, fixed and often relieved by pressure.
Vomiting..	*Vomiting*, rapidly becoming fecal.	Intermittent and fecal toward the last.	Occasional during attack of pain.	Rapidly becoming fecal in acute cases, absent or intermittent in chronic.
Collapse.....	*Collapse*, very marked.	Absent till the end.	Absent till late.	Very marked in acute cases, not so in chronic.
Constipation.....	Absolute constipation and inability to pass flatus.	Gradually increasing in severity.	Attacks of constipation, alternating with natural relief.	Occasionally present, but, as a rule, "dysenteric" symptoms, straining, tenesmus, muco-sanguineous stools, or hemorrhage.
Abdominal distension.	Rapid and severe, central and hypogastric.	Gradually increasing, lumbar and epigastric.	Never great, increased during attack.	Rarely severe.
Manipular indications.	Tympanitic, distended coils at times to be felt.	A fixed swelling at times to be felt in either iliac fossa.	A doughy condition of bowel, becoming knotty during attack.	Distinct tumor often to be felt, its shape varying during attack.
Visible indications...	Abdomen tense in umbilical and hypogastric regions, with visibly distended coils.	Abdomen broadly distended, coils of intestine visible.	Coils of intestine very visible.	Nothing marked to be seen.
Peristalsis.....	Rarely visible.	Marked.	Very marked.	Not visible.
Urine.....	Scanty or suppressed.	Natural in quantity.	Natural.	Natural
Rectal examination..	Lower bowel probably quite empty.	Stricture of bowel may be felt in rectum or in sigmoid flexure by manual examination.	Nothing abnormal.	Rectum may contain mucus, blood clot, or invaginated bowel.

Chronic Intestinal Obstruction

now claims attention, and it is to be observed *in limine* that the clinical history of these cases is very distinct from that of the acute; for whereas in the "acute" the symptoms appear, as a rule, suddenly in patients who have been apparently in good health, in the "chronic" it will almost always be found that there has been for a more or less lengthened period some abdominal pain or symptom, some difficulty in obtaining a movement of the bowels or in the act of defecation, some discharge, probably, of glairy mucus, of pus, or of blood, separately or combined, at uncertain intervals, and last, but not least, some change in the form and character of the stools, the motions at one time being liquid and loose, at another hard and marble-like, while at intervals they are pipe- or tape-like. Under all circumstances there will be symptoms of long standing; and if acute symptoms exist when the case comes under notice, they will be found to have been grafted upon the old. If, therefore, we are called to see a patient suffering from marked symptoms of obstruction of some days' duration and obtain such a history of the case as has just been sketched, and find him with abdominal tympanitic distension, and probably pain, possibly visible peristalsis, nausea, vomiting, hiccough, and borborygmi, we may safely come to the conclusion that the case is one of chronic obstruction, and that it has for its cause one of those named in the table (page 501). It will prove to be stricture of either the colon or the rectum, the mechanical pressure of a pelvic or abdominal tumor, the matting together of the intestinal coils from old or chronic inflammation of the peritoneum or mesentery or from cancerous abscess, and last, but not least, to fecal accumulations;

and in every case of obstruction the last possibility being the cause should be borne in mind. Rare instances are also on record in which other causes have existed, and I have given, in the chapter on hernia, some in which the obstruction had been clearly traced to the influence of an adhesion between the bowel and a hernial sac or some part of the abdominal parietes, or to an obstructed obturator or other hernia.

The effects of obstruction, from whatever cause, are very uniform, and every case will terminate fatally from either exhaustion or peritonitis if the obstruction is not overcome. When chronic peritonitis occurs, it is due to the obstruction; and when the peritonitis is acute, it is due either to a perforating ulcer of the sigmoid flexure secondary to the stricture, to some ulceration of the cæcum or colon the result of overdistension, or to the mechanical rupture of the cæcum the direct result of the pressure of the fecal accumulation acting backward upon the cæcal *cul-de-sac*. My notes describe two cases in which the cæcum burst—one in which it was purple in color and measured fifteen inches round, and another in which it had sloughed. I have also notes of a case of a male child born with an imperforate rectum who died on the sixth day from ruptured cæcum. And out of eleven consecutive fatal cases of untreated stricture of the rectum at Guy's Hospital, collected by my dresser, Mr. Russell, death was caused by ruptured cæcum in three, by perforation of the sigmoid flexure in two, by peritonitis after puncture to relieve flatus in one, and by exhaustion in three. Hence the importance of early relief before these changes have been started. These points have been ably brought out in Coupland and Morris's paper.

Diagnosis.—To diagnose the true cause of the obstruction is therefore the surgeon's next aim, and it would be well if I were able to add that the task is an easy one, but such is not the case. It is true that when the obstruction is in the rectum a digital examination of the part may find it out, that when in the sigmoid flexure the cautious introduction of the whole hand into the rectum (after the method of Simon of Heidelberg) may detect it, and that when a tumor is to be felt by palpation to the left of the umbilicus, through the abdominal walls, the probability is suggested of the disease being in the colon; but without these guides little definite knowledge is to be obtained by either palpation or percussion, by the passage of the long tube, or by the amount of fluid that may be injected into the colon.

Under these circumstances, therefore, the surgeon is thrown back upon the probabilities of the case as read by the light of pathological knowledge; and it is gratifying to be able to show that these facts speak with no uncertain sound. Indeed, they speak so strongly and decidedly that the surgeon may rely upon them with confidence and base his practice upon their indications.

The facts are revealed in the table to which I have already drawn attention. There it will be seen that out of the 76 fatal cases of chronic obstruction, 3 were due to fecal impaction, 3 to the mechanical pressure of tumors, 23 to what Dr. Fagge described as "contraction," caused by the matting together of the intestinal coils from peritoneal or cancerous disease, and 47 to strictures of the bowel.

Now, cases of fecal accumulation do not require any lengthened treatment in these pages. When they come under the surgeon's care as examples of obstruction, they are to be treated by the mechanical removal of the feces from the rectum by such means as the finger, the lithotomy scoop, or the handle of an iron spoon, these measures being aided materially by the free use of grease, oily enemata, and medicines.

The fact that fecal accumulation may give rise to the worst symptoms of mechanical obstruction, and even to death, should always be before the surgeon and induce him to examine the rectum with care in all cases of obstruction.

Obstructions due to the presence of some abdominal tumor, hydatid, cancerous, ovarian, or otherwise, are to be diagnosed and dealt with on their own merits, although, when it is the lower part of the bowel that is obstructed, right or left lumbar colotomy should not be neglected when other means of relief are not available. I have performed this operation on most occasions for such a cause with gratifying success.

We come now to the two larger divisions of cases—viz., those of *stricture* and *contraction;* and a very little consideration will show that these cases have as distinct a clinical history as they have a pathology, and that they moreover require a distinct line of treatment.

With respect to their pathology, it may at once be stated that "contraction" is the cause of chronic obstruction of the small intestines, and "stricture" of obstruction of the large bowel; that the cases of "contraction" are due to the matting together of the intestinal coils from more or less diffused inflammatory or cancerous peritoneal disease,

while cases of stricture are due to a local narrowing of the bowel from disease of its coats.

In the cases of "contraction" the action of the intestines (small or large) is interfered with from adhesions or from a bending or doubling of the bowel upon itself, and consequently there is an interference with the peristaltic movements; in those of "stricture," the action of the bowels is prevented from the direct mechanical obstruction occasioned by the stricture.

The clinical history and symptoms of these two classes of cases consequently differ.

In the case of "contraction" the symptoms are clearly referable to a difficulty in the passage downward of the intestinal contents: in that of "stricture," to a difficulty in defecation.

In the *former* case the symptoms are attacks of griping, colicky abdominal pain, irregular and incomplete intestinal evacuations, and the painless discharge of healthy motions; in the *latter* there is mostly an absence of abdominal pain beyond that due to distension, more or less complete constipation, alternating with looseness of bowels, the occasional or frequent mixture of mucus or blood with the motions, and painful defecation.

In "contraction," when sickness exists, it will be passing and lasting only during the attack of colicky pain; in "stricture" it will occur toward the close of the disease when the obstruction is more complete.

In "contractions" the abdomen probably will not be much distended, and, if it be so, only during the attack; the distension, moreover, will be central and hypogastric. "The intestines will then," writes Fagge, "be seen writhing and coiling, and a gurgling of fluid is heard; there will also be visible distinct peristaltic movements of the intestines." In "stricture" the abdomen will to a certainty be distended, and the distension will be lumbar and epigastric; large coils of distended bowel will also be visible with peristaltic movements, the visible peristalsis in both cases being due to the chronicity of the affection, and consequently to the hypertrophy of the bowel from overwork.

Such, then, are the broad points of distinction between the two large classes of cases of chronic intestinal obstruction, and they are enough to guide the surgeon in his practice. At times, however, the distinctions fail. Indeed, when a history of a case of either contraction or stricture is deficient, the diagnosis is most difficult; and if seen when the symptoms are at their height, one or other may be mistaken for a case of acute obstruction, the chronic symptoms of which nothing can be known having lighted up into the visibly acute, in the same way as a case of incarcerated or obstructed hernia may suddenly develop into one of acute strangulation.

Having, then, thus mapped out the chief points of distinction between the two classes of cases of chronic intestinal obstruction, and bearing in mind that in the "contractions" the small intestines are the parts that are involved and in the "strictures" the large, it remains for the surgeon in the latter class of cases to determine the seat of the disease, for a correct knowledge upon this point is clearly requisite before any precise operative treatment can be entertained. On reference to the table this point comes out very strongly; for, out of 104 cases which have been tabulated, in 78 the disease was in the sigmoid flexure or rectum, in 19 it was in the colon or one of its flexures, and in 7 it was about the cæcum. In three-fourths of the cases the disease was consequently below that part of the bowel that would be opened by left lumbar colotomy, and in about four-fifths below the seat of right lumbar colotomy; in but a very insignificant number was it higher up.

With these hard facts before us, the conclusion seems tolerably clear that in all cases of obstinate constipation due to mechanical obstruction in the large intestine, when medicinal treatment has failed and the removal of the disease by operative measures is out of the question, instead of wasting valuable time by the persistent administration of aperients which must do harm, of enemata which can do no good, of opium and allied remedies which only mask symptoms and mislead the practitioner, colotomy should be performed. The operation should be in the *left* loin when the diagnosis has been made of disease of the rectum or sigmoid flexure, and in the *right* when the exact position of the stricture cannot be determined, for from our table it would appear that in not one case in fifteen is it likely to be above this point; right lumbar colotomy also, so far as the relief it gives is concerned, is as satisfactory an operation as left. It must be stated, moreover, that this relief should not be postponed too long, because, from the facts alleged, the operation will be of little avail when from the mechanical effects of the fecal distension a peritoneal inflammation has set in, or changes have taken place in the cæcum or large intestine of an ulcerative or inflammatory character.

With respect to the treatment of "contractions," much may be done by judicious medical measures, more particularly by helping the passage onward of the contents of the intestinal canal by means of laxatives, those of an oily kind being the best, such as the oily mixture of the Guy's Pharmacopœia.

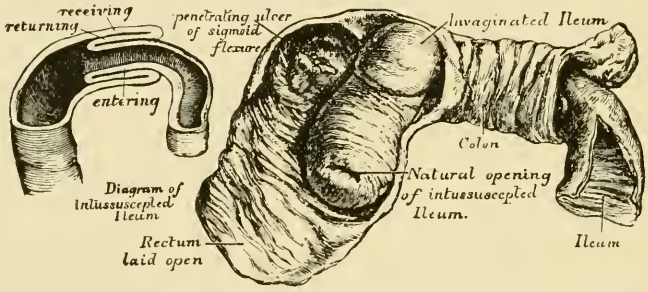
A time will, however, come when these means will fail and others must be looked for, unless the patient be left to his fate; and of these "enterotomy" is most applicable. The operation consists in opening the small intestine in the right or left iliac fossa, and so establishing an artificial anus.

The operation will be considered farther on.

Intussusceptions,

or the invagination of some portion of the bowel into a lower segment (Fig. 287), may occur at any period, though most common in infancy and child-life. They may take place also in any part of the intestine, my table recording that out of the 15 cases tabu-

Fig. 287.



Intussusception, with Diagram showing the Entering, Returning, and Receiving Layers of Ileum into Colon.

lated 2 were rectal, 7 ileo-cæcal, and 6 small intestine. The statistics are supported by Gay's analysis of 74 cases, in which 8 involved the large intestine alone and were colic, 33 ileo-cæcal, and 33 small intestine. The rectal variety is, however, more frequently found in the adult, the iliac in young adults, and the ileo-cæcal in infancy and childhood. When the invaginated portion of intestine becomes *strangulated*, the symptoms are acute; when simply *incarcerated*, they may be chronic. Sudden invasion of symptoms, however, is the rule in both forms, with tenesmus and muco-sanguineous discharges, more particularly when the ileum is involved; discharge of blood *per rectum* occurs in the acutest cases.

Symptoms.—The symptoms may be very acute and destroy life in three days, or so mild as to be only those of intestinal irritation. The development of symptoms, as well pointed out by Mr. Howard Marsh (*St. Barth. Rep.*, vol. xii., 1876, p. 98), depends upon the occurrence of constriction—an intussusception in this respect being like a hernia, which may be "down" without being strangulated or even obstructed—the various symptoms in each case depending, not on the mere displacement of the intestine, but on the constriction produced by the displacement.

When *acute*, a case of intussusception at its onset may be mistaken for one of strangulation by a "band;" and yet marked points of difference exist between the two. In both the attack is sudden and followed by collapse, but in the case of a *band* pain is localized from the first, is paroxysmal and remains severe to the last, and is also unassociated with tenesmus. In the *intussusception* pain varies much in both seat and intensity, is often relieved by pressure, and toward the last ceases. The pain is likewise commonly associated with tenesmus. In strangulation by a "band" vomiting soon becomes fecal and is constant; in "intussusception" it may also be the same, but it as often ceases. In "band" constipation is the rule, with inability to pass flatus; in "intussusception" diarrhœa, tenesmus, and bloody mucoid stools are characteristic; constipation is, however, at times present in chronic cases. In "band" central and hypogastric abdominal distension is an early symptom; in "intussusception" it may never exist. In "band" the most that may be felt is a single coil of distended bowel; in "intussusception" a distinct tumor may be felt.

Dr. Leichtenstein of Tübingen, in a valuable analysis of 593 cases of this affection (*Prager Vierteljahrschrift*, Bd. 119, 121, 1874), informs us that when a tumor is recognized in the epigastric region the ileum is probably the part invaginated; when in the

right iliac fossa, the ileum into the cæcum; and when it can be felt in the rectum, it is probably ileum. Mr. Morris (*Path. Trans.*, p. 133, 1877) has, however, pointed out the possibility of mistaking blood clot in the rectum for the lower end of intussusceipted bowel; so that the use of the speculum should be brought to the aid of the finger in any case of doubt. Leichtenstein says also that when the intussusceipted portion of bowel sloughs off it occurs between the eleventh and twenty-first days from the beginning of the disease, and that it is generally part of the ileum. This result, however, is very rarely met with in infancy.

Treatment.—In the treatment of intussusception operative interference is not to be undertaken in a hurry, as it is not to be questioned that cases of this affection constantly occur which right themselves either by, or even without, the aid of medical or surgical treatment, the bowel either freeing itself by an unexplained process or in some acute cases sloughing away, and a so-called cure resulting. Fagge, however, well observes upon this point that "when this cure by expulsion occurs it frequently only postpones the fatal termination instead of entirely preventing it. The patient dies some months afterward from contraction of the cicatrix which had formed at the seat of the disease, this fact affording a weighty additional argument in favor of an attempt to explore and pull out an ileo-cæcal intussusception when the case is correctly diagnosed at an early stage." Mr. Morris says, "It would appear that when small intestine is intussuscepted into *small* intestine the *invaginating* portion, owing to its small relative size, is too much damaged by compression from within to allow of recovery by expulsion of the reflected and entering portions."

No operation should, however, be thought of in intussusception until well-considered minor measures have been employed and failed, care being taken that too much time is not expended upon them. In *acute* intussusception, however, where the bowel is clearly strangulated, but a few hours should be given, because, unless relief is speedily found, death ensues; and the younger the patient, the more rapid the result.

In *chronic* intussusception, where the bowel is probably only incarcerated, the surgeon should not withold his hand for more than a week, because, if relief is to be obtained by treatment, it should be obtained within the seven days it is justifiable to expend in the attempt; and if failure follows, the operation of laparotomy should be undertaken. In acute strangulation, if relief is not speedily found, sloughing of the invaginated bowel may take place; and in the chronic, adhesion of the invaginated bowel. Under either circumstance operative interference must fail.

Operative interference in intussusception, however, has not hitherto been very successful, and its failure, I believe, is owing to its having always been postponed to too late a period. Yet recent experience has been more encouraging, even under not very favorable circumstances, for Hutchinson has recorded a case (*Med.-Chir. Trans.*, vol. lvii., 1874) in which he opened the abdomen of a child æt. 2 on the thirteenth day of the symptoms and drew out the invaginated bowel with a successful issue. Mr. Howard Marsh had a second case, in which a like good result was obtained in a male infant seven months old after symptoms of fourteen days' duration; while my colleague, Mr. Howse, had a third, in a woman æt. 23, a patient of Dr. Fagge (*ibid.*, vol. lix., 1876), in which recovery took place. I have likewise performed the same operation in a dog, pulling out on the fifteenth day six feet of invaginated bowel with a good result.

Dr. H. B. Sands of New York has also published another successful case, in a child six months old (*New York Med. Journ.*, June, 1877), the operation having been performed eighteen hours after the appearance of the symptoms. In intussusception, however, some success has followed, at times, the practice of inflation—a plan of treatment that was originally recommended by Gorham years ago. When inflation cannot be used, injections may be substituted. This operation has, however, its dangers, as bowels have been ruptured by its use. I cannot, therefore, recommend it.

Inversion of the body has likewise been advised, with the chance that the weight of the contents of the bowel above the involuted or obstructed segment may suffice to disengage it. Mechanical kneading of the abdomen and the administration of an anæsthetic have also been employed with a similar object.

Opium should always be given in all cases of mechanical obstruction, the drug not only relieving pain, but checking the peristaltic action of the bowel which is so injurious.

These remedies, however, are doubtful at the best; they should, however, be tried in early cases, as well as when the diagnosis is uncertain; they must not be used when the diagnosis is certain or more active treatment is called for unless such treatment is absolutely rejected.

Laparotomy

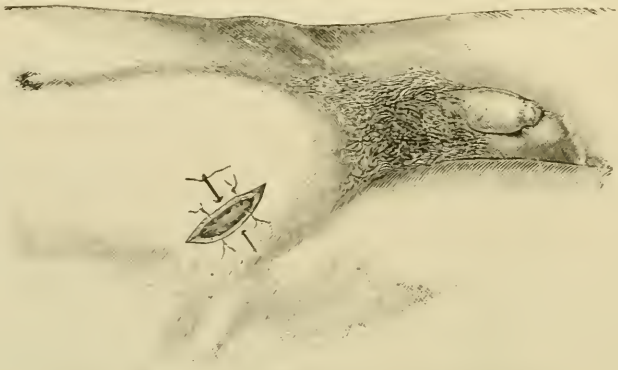
(from λαπαρα, "the soft parts of the body below the ribs," and τεμνω, "I cut") is a name which has been given by Dr. John Ashhurst, Jr. (*American Journ. of Med. Science*, 1874), to an exploratory operation upon the abdomen for the relief of an internal strangulation or intussusception, and is so good that I adopt it. The term "gastrotomy" is applied to operations upon the stomach for the removal of foreign bodies; "gastrostomy," to an operation upon the stomach with a view of establishing a permanent fistula; "colotomy," to those upon the large intestine; and "enterotomy," to those upon the small.

In laparotomy the abdomen should be opened in the median line below the umbilicus, though, if an old hernia exist, the sac should be explored and the abdominal incision made upward from its neck. The abdomen should at first be explored by the finger, and more particularly toward the umbilicus, since it seems that bands are more often found opposite the promontory of the sacrum than anywhere else. The finger should then be passed toward the right iliac fossa, to examine the cæcum and to feel for the contracted empty small intestine which so frequently dips into the pelvis at this spot, and if found forms the best guide to and proof of intestinal obstruction. If the finger fail to find out the seat of obstruction, the opening must be enlarged and the parts inspected. When the operation is performed for intussusception and the bowel is exposed, difficulty has been experienced in freeing the involved bowel, and under such circumstances the expedient used by Mr. Hutchinson should be employed and the invaginated portion pushed out backward from its sheath. After the operation the peritoneal cavity should be well cleansed with antiseptic sponges and the wound carefully adjusted by stitches. The patient should be kept under the influence of opium or morphia, the morphia suppository every five hours being the best form to use. Milk diet should be given in small quantities; and if recovery is to follow, it will probably be speedy, as repair takes place rapidly in all abdominal sections when a case goes on well, and death ensues early when the reverse occurs. Ashhurst has collected 123 cases of laparotomy, of which 37 recovered and 86 died.

Enterotomy,

or the opening of some portion of the small bowel, generally in the right groin, is an operation of great value, and it is to be regretted that it has not received sufficient notice. It was first performed by Nélaton, at least twenty-five years ago, upon a patient of Trousseau for chronic intestinal obstruction, and is applicable to cases of abdominal obstruction in which the clinical evidence points to the conclusion that the obstruction is high up in the large intestine or low down in the small; to cases in which "laparotomy" is inapplicable and "lumbar colotomy" is out of court; to cases of obstruction in which relief is required and a more exact method of giving it is not clear, either from some difficulty in diagnosis or other cause. It is described by Trousseau as follows (*Clin. Med.*, Lec-

Fig. 288.



Inguinal Wound made in Nélaton's Operation of Enterotomy.

ture 77): "I begin the operation, as Nélaton advises, by making in the right side an incision an inch in length, a little above the crest of the ilium, parallel with Poupart's ligament (Fig. 288); the length of this incision is subsequently increased to three or

four inches. In dividing, layer by layer, the skin, the cellular tissue, the muscles, and aponeuroses, tying as may be required the large vessels involved in the incision, we at last come to the most deeply-seated aponeurosis. Proceeding always very slowly and being very particular in sponging the wound carefully, this deep aponeurosis is cut through, when forthwith the peritoneum is reached. It is taken hold of by a small forceps and incised; afterward, using the greatest possible precautions, a silver thread is carried by means of a curved needle, first through the intestine and then through the abdominal walls; four sutures are then made, two on each side of the incision; two others are made, one at the superior and the other at the inferior angle of the wound; but this time the abdominal parietes are first perforated, then the intestine, and afterward the abdominal parietes on the opposite side of the wound. (*Vide* Fig. 289.) In this way the intestine is fixed everywhere, laterally and from above downward to the walls of the abdomen; by this proceeding no exudation can take place into the peritoneum. *It is then only necessary to make an exceedingly small incision in the intestine* by means of a sharp-pointed bistoury. The opening which Nélaton makes is less than a third of an inch."

Fig. 289.

Mode of securing Bowel before opening it.

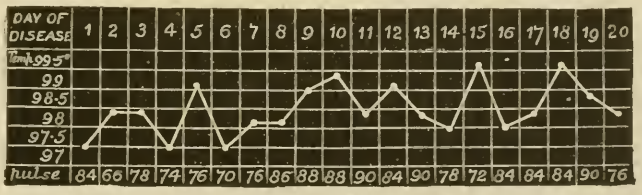
If the case is not so urgent as to demand immediate relief, it would be well to postpone opening the small intestine for one or two days, in order to give time for firm adhesion to take place between the bowel and the abdominal parietes. Indeed, it may be a question whether it is necessary to fix the intestine to the abdominal parietes by sutures, and whether it will not adhere to the part as a result of its simple exposure in the wound.

This operation is very warmly advocated by Trousseau in all cases of intestinal occlusion, from whatever cause, "when the symptoms of occlusion have existed for six or eight days, when there is great tympanitis, when the matters vomited are of a stercoraceous character, and, finally, when the persistence and severity of the symptoms presage imminent death." He had recommended its adoption in five cases, and in two with complete success, the patients recovering, who without it would have been hopelessly lost.

In recent times this operation has been successfully performed by Mr. McCarthy on the suggestion of Mr. Maunder in 1872 (*Med.-Chir. Trans.*, vol. lv.), by Mr. Wagstaffe (*St. Thomas's Hosp. Rep.*, 1873), by Mr. Maunder himself in November, 1875 (*Trans. Clin. Soc.*, vol. ix., 1876), and by others.

I have performed it three times—once in 1876 on an infant twelve days old, who was born with an imperforate rectum, and survived the operation eight days, having been greatly relieved by it, but operation had been postponed until too late. The second was in May, 1877, on a man æt. 57 who had been a patient of Dr. Wilks for chronic obstruction of small intestine of many months' standing, the chronic condition being aggravated every week or ten days by symptoms of a severe character which threatened life. The seat of the obstruction was too uncertain to allow of the operation of colotomy being performed; indeed, the symptoms pointed to the small bowel as being the seat of the disease, and on that account enterotomy was undertaken. The operation gave rapid and permanent relief, and the man was convalescent in a month. His temperature, as shown by the chart, was never higher than 100°. He is alive and well at the present day, but the

Fig. 290.



Thermograph of Case of Enterotomy in a Man æt. 57 for Chronic Obstruction.
(Temperature never reached 100°, and patient was convalescent in a month. Fluctuation of temperature very slight.)

inconvenience connected with the artificial anus is so troublesome as to neutralize greatly the advantages of the operation. The third was on the person of a man æt. 50 whom I saw in consultation with Dr. Cortis of Kennington in July, 1877, for complete intestinal obstruction. He had been ill two months with abdominal pain and constipation, but sought advice only when the pain had become very severe and vomiting appeared. When I saw him, the constipation was insuperable, vomiting incessant, and the abdomen much

distended. No obstruction could be felt in the rectum; both loins were very resonant, and it was believed that the obstruction was about the cæcum. I consequently performed Nélaton's operation of enterotomy, as described, on July 7. The operation gave immediate relief and everything went on well subsequently, the temperature never rising beyond 99°. He left the hospital six weeks afterward, the whole of his motions passing through the artificial anus and not a trace of wind or motion passing *per anum*.

On his return home, for want of good nursing, a bed-sore appeared, and he died in November, 1877. After death it was found that the lower part of the ileum had been opened three inches from the cæcum, and that the seat of stricture was in the ascending colon, just above the cæcum. It was cicatricial and evidently due to the contraction of some old ulcer; the viscera were healthy. I subsequently learnt from Dr. Cortis that this patient had hurt himself in the right side of his abdomen three years before his illness in a fall over a case of goods, and that the accident was followed by sickness and pain, with nausea and occasional vomiting. It is quite possible that the stricture was the result of this injury.

This patient, as well as the other, complained sadly of the annoyance caused by the constant flow of feces from the inguinal anus, no mechanical appliance having the power of controlling it.

Colectomy.

This term is applicable to cases in which a portion of the colon has been removed either by abdominal section or through a lumbar wound. Under the former circumstances the operation might be called "abdominal," and under the latter "lumbar," colectomy.

I was the first to suggest and to perform the latter operation in this country, and I did so on September 10, 1881, for a lady æt. 50 who had suffered from eight weeks' obstruction, with such success that she lived between thirteen and fourteen months, and died October 29, 1882, of cancer of her liver and spleen. (See *Med.-Chir. Trans.*, vol. lxv., 1882).

Operation.—I commenced the operation with my usual oblique lumbar incision, as for "colotomy," and, having reached the bowel and found that the strictured portion could be drawn out of the wound, I determined to excise it. This I did by first stretching the presenting wall of the intestine above the strictured portion to the margins of the wound, evacuating the contents of the bowel through a limited orifice, and subsequently securing the under lip of the upper portion of bowel to the lower margin of the wound, having with scissors carefully detached the strictured segment of the colon from its upper attachments and stretched the bowel to the orifice of the wound step by step.

The strictured segment of gut was then separated from its attachments below, and the upper orifice of the lower portion of the bowel carefully secured to the wound in close contact with the upper portion. Great care was observed all this time to keep the parts clean and prevent anything gravitating into the abdominal cavity.

The operation was not a difficult one.

The idea of removing an organic structure of the large bowel through the wound made for a left lumbar colotomy suggested itself to me several years ago, after having seen, in operations of colotomy as well as in the post-mortem room, many examples of annular or localized stricture of the bowel which were freely movable in the peritoneal cavity, free from all attachments, and within easy reach of the surgeon's fingers through the lumbar wound. For it is in these cases, and in these alone, that the operation is possible.

The thought was likewise encouraged by the analyses of cases tabulated on page 501, from which it was shown that in three out of four cases of chronic intestinal obstruction the stricture is located in the descending colon, and that in about one-third of these cases the disease is of an annular or local character, such strictures being the least malignant of epithelial growths.

Should this operation meet with the support it deserves, some change in practice may be required; for it would be wise to entertain the operation of colectomy at an earlier period of the stricture's progress than it has hitherto been the custom for physicians or the majority of surgeons to entertain that of colotomy, since the operation of colectomy would be more readily performed when the bowel above the stricture is undistended and comparatively healthy than when it is full of retained feces and probably ulcerated from overdistension. The operation, moreover, when performed under those more favorable circumstances, would be safer, since in the healthy bowel above and below the strictured segment the surgeon may with more confidence draw the inward portion upward from the

pelvis or downward and backward from the splenic region, and consequently remove it with greater safety and facility.

The consideration of colectomy in any given case will consequently give a help to colotomy where it is most needed, for it will encourage medical men to entertain the question of operative relief for obstruction as soon as the diagnosis of organic stricture has been made, and not to postpone it till, as I have heard it advised, obstruction has existed for six weeks, when the chances of success by any operation are indeed small.

I believe the operation of colectomy for the treatment of localized strictures of the sigmoid flexure will be found to be a valuable additional means of giving relief, and possibly of curing a certain proportion of cases. It should be considered in all case of stricture of the descending bowel not rectal, and entertained as soon as the diagnosis of the case has been made and before symptoms of obstruction are a source of anxiety or of a threatening character.

Since the one recorded I have seen two cases in which the operation seemed desirable. In one the advice was rejected, in the other it was acted upon; and the surgeon who performed it found the diagnosis correct and removed the stricture, but without success. My friend Mr. John Marshall has recorded a later case in the *Lancet* for May 6, 1882, and has given an interesting lecture upon the subject which may be read with benefit.

Colotomy.

For irremediable stricture or mechanical obstruction of the rectum from any cause, when colectomy is inapplicable, *Callisen's* operation of opening the colon in the *left* loin should be followed; but when the seat of obstruction is higher than the rectum, and if there be a doubt whether it is in the sigmoid flexure or transverse colon, *Amussat's* operation in the right loin should be performed. Callisen first suggested colotomy in 1796 and applied it to the descending colon, but Amussat revived the operation and extended it to the ascending colon in 1839.

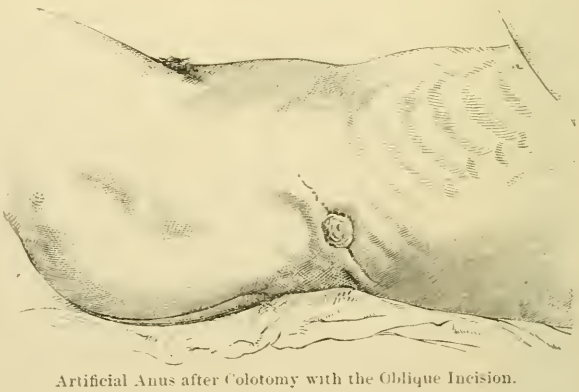
The colon in this position lies behind the peritoneum, immediately beneath the transversalis fascia. The kidney is in close contact with it above, and in one case on which I operated the organ was placed so low down as to fill in the space between the rib and pelvis, and had to be pushed upward to allow the colon to be seen and opened. The operation on the left loin can be performed as follows:

The patient is to be placed on his right side, with a pillow beneath the loin, in order to arch somewhat the left flank, and he should be turned two-thirds over on his face; the outer border of the erector spinæ and of the quadratus lumborum muscle can then be made out, this latter muscle, which is on a deeper plane, being the surgeon's main guide. Its outer border, with the descending colon, is to be found half an inch to an inch posterior to the centre of the crest of the ilium, the centre being the point midway between the anterior and posterior superior spinous processes. Allingham says that in more than fifty dissections he has always found the descending colon to be situated at the former point. When difficulties are felt in the operation, he believes they arise from the colon being looked for too far from the spine (*St. Thomas's Hospital Reports*, 1870), and in that opinion I cordially agree. An incision is then to be made, four or five inches long, beginning an inch and a half to the left of the spine, below the last rib, and passing downward and forward parallel with the crest of the ilium; the line of the incision should pass obliquely across the external border of the quadratus lumborum muscle about its centre, so as to take the same direction as the nerves which traverse this part. By this incision the integuments and muscles and fascia are divided and the outer border of the quadratus muscle exposed. The abdominal muscles can be divided, to give room. All vessels are now to be secured. The transversalis fascia will next come into view, and beneath this will be the colon, a layer of fat intervening. The fascia is to be opened with caution, for in the loose fat and cellular tissue the colon is to be found. When distended, the bowel, on dividing the fascia, comes at once under the eye; but when empty, some little trouble may be experienced in hooking it up with the finger. The inflation of the colon with air by means of an enema syringe or Lund's apparatus is at this stage of the operation often of great assistance, the inflated bowel rolling up into the wound in a very satisfactory manner. The bowel can always be found in front of the lower border of the kidney. This organ should, consequently, be sought, as it is the only certain guide to the bowel. I have found, however, on several occasions, at this stage of the proceeding, great help by rolling the patient over on his back, the bowel falling by this manœuvre on the finger and being then readily caught.

When the bowel has been caught, it should be partially rolled forward, in order to expose its posterior surface; for if this be not done, there is a risk of the surgeon wounding the peritoneum where it is reflected from its anterior surface on to the abdominal wall. The bowel, having been drawn up to the wound, is then to be secured to the integument, and not to the muscles, by the passage of a ligature introduced through one margin of the wound, then through the bowel, and lastly through the other margin. The bowel can then be opened by an incision about half an inch long between the ligatures that have traversed its canal: the centres of the ligatures are then to be drawn out through the wound and divided, the two halves of the ligatures fixing the two sides of the divided intestine firmly to the margins of the wound; two or more stitches may then be introduced, to make the artificial anus secure. When the necessity of giving relief to obstruction is not great, the bowel may be carefully stitched to the margins of the wound and opened, as in enterotomy and gastrostomy, on the third or fourth day, the risks of peritonitis being diminished by this means. The surgeon may, however, do what my colleague Mr. Howse has done—simply draw the bowel out of the wound and hold it out for two or three days by means of forceps, when the protruded bowel will have become firmly united to the margins of the wound and may be opened with safety or removed as in a colectomy. The margins of the wound may be oiled, to guard against the irritation of feces, and the patient placed in bed. At times the feces escape in large quantities directly the bowel is opened: at others some slight feculent discharge will take place at the time, the larger flow taking place later. This is not, however, a matter of any importance, and the surgeon should take no measures to cause the bowels to act: indeed, it is better, so far as the operation is concerned, that the flow be postponed, for within an hour or so the parts about the wound become sealed with lymph, and thus the risks of extravasation are diminished.

Callisen originally suggested the *vertical* incision in the left loin, and Amussat the *transverse* in the right, the latter crossing at right angles the outer border of the quadratus lumborum muscle, the former running parallel with it. The *oblique* appears to me to be preferable to either, as it gives more room for manipulation when the colon is empty; it takes the line of the nerves and vessels that traverse this part and lessens the risk of their division; it follows the ordinary integumental fold of a patient when assuming the recumbent posture, and thus favors repair, and seems to tend much toward the prevention of the prolapse of the bowel that is always liable to follow such an operation. Fig. 291 illustrates the line of incision and the appearance of the artificial anus. It was taken from a patient æt. 64 whom I operated upon in 1869 for vesico-intestinal fistula, and who died five and a half years subsequently (1875) from a ruptured heart. The gentleman followed his avocation without any discomfort.

FIG. 291.



Artificial Anus after Colotomy with the Oblique Incision.

AFTER-TREATMENT.—After the operation a sedative should be given, such as opium, morphia, or chloral, and the recumbent position maintained, a piece of oil lint covered with oakum and kept in place with a soft towel being the best application.

The sutures may be removed on the fourth or fifth day, according to circumstances, while perfect cleanliness must be observed.

Nutritive food and stimulants may be given within a day or so of the operation, repair, as a rule, going on favorably.

When the wound has cicatrized, the patient may get up and a pad be applied, covered by a folded napkin and fastened on with a lumbar binder or a pure rubber plug and shield as made for me by Messrs. Krohne of 8 Duke street, Manchester Square.

With the oblique incision the prolapse of the bowel does not appear to be the cause of much annoyance, since it seems to take place to a very slight extent.

When contraction of the orifice takes place to too great an extent, a sponge tent or

short bougie may daily be introduced. I have, however, met with but one case requiring this treatment.

After convalescence it is well occasionally to wash out the lower portion of the bowel with warm water, as some feces are apt to pass the artificial opening and rest in the rectum, causing irritation. When the anal end is open, it is best to do this through the natural opening; and when closed, through the artificial.

Prognosis.—I have now performed this operation about eighty times, and in no single case have I ever regretted doing so, although in a large number I have wished earnestly that I had had an opportunity of performing it earlier, since in no instance did it fail to give relief. One of the cases of vesico-intestinal fistula lived nearly six years after the operation, and died æt. 70 from rupture of the heart. Another is now alive, thirteen years after the operation, and enjoying life, suffering, indeed, very little inconvenience from the artificial anus (*Clin. Soc.*, 1872). The patient with fibrous growths in the rectum was operated upon November 14, 1877, and is now living in comfort.

Of the patients with stricture, cancerous and otherwise, one lived five years, two four, three lived three years after the operation, several two, and very many one. Many were alive when last heard of, two having been operated upon three years previously, two two years, and two within the year. In every case marked relief was afforded to symptoms, and in many the patients' expressions of gratitude for such were very strong, several having deeply regretted that the operation had not been performed at an earlier period. In many of these cases the operation was undertaken as a last resource.

In one of the patients colotomized for vesico-intestinal fistula, who is now alive, thirteen years after the operation, urine finds its way, when he is recumbent, out of the lumbar artificial anus; and in another, who survived the operation nearly six years, the same complication presented itself. In neither instance, however, was the flow a source of trouble. This flow, however, might have been enough to keep patent that portion of the intestine that existed between the artificial anus and the bladder and to preserve it from atrophy, such a result of colotomy being clearly possible. The late Dr. Michael Harris of Liverpool recorded in the *Liverpool Hospital Reports* for 1874 the particulars of a post-mortem examination where Mr. Hakes had performed colotomy five years previously for vesico-intestinal fistula, in which the descending colon from the artificial anus, together with the sigmoid flexure and rectum as far as the bladder, had become *completely obliterated* and was found to be replaced by a cylindrical mass of fat. The length of this fatty column was about six or seven inches, and in the centre of it was found a fibrous cord of about a line in thickness, but no trace of a canal of any kind could be therein detected.

The operation of colotomy is beneficial in all cases of vesico-intestinal fistula when solid feces flow with the urine; in all cases of stricture of the rectum that cannot be removed by colectomy so soon as the obstruction becomes serious and local distress great; in all other cases of mechanical obstruction to the rectum from pelvic causes when no less severe measures for relief can be suggested; and, last, but not least, in extensive ulceration of the rectum, cancerous, syphilitic, or simple, when local treatment fails to give relief and local distress is great, when the general powers are evidently giving way from the local disease quite irrespective of mechanical obstruction.

In no case, however, should the operation be postponed till the patient's powers are failing, when the prospects of recovery would be greatly lessened and convalescence is often rendered improbable.

Summary.—By way of summary, therefore, it may be stated that—

Laparotomy is an operation which should be performed in all cases of acute intestinal obstruction due to bands, internal hernia, and intussusception that do not speedily yield to other treatment.

Lumbar Colectomy should be performed when the stricture in the large intestine is annular, localized, and movable.

Colotomy is applicable to cases of obstruction to the large intestine from stricture or the mechanical pressure of tumors that cannot be relieved by other means.

Enterotomy affords a means of relief for all other cases of intestinal obstruction to which the two former operations are inapplicable, and more particularly when the small intestines are involved.

REMARKS.

I have been induced to tabulate and analyze my own cases of lumbar colotomy, and to embody the results of the analysis in a paper which I read at the Copenhagen Medical Congress, 1884. (See *Transactions.*)

The Tables and the conclusions drawn from the analysis and consideration of them tell much in favor of lumbar colotomy, and on that account I have deemed it expedient to introduce them in this volume.

The conclusions to which I was led in my paper were embodied in the following propositions, which I believe my material proved:

TABLE I.—Cases of Lumbar Colotomy for Cancer

No.	Hospital or Private Patient.	Name of Patient.	Age.	Date of Operation.	Colotomy Right or Left.
1	Hospital.—Dr. T. Addison.	Mary P——.	48	Oct. 6, 1859.	Left.
2	*Private.*	Mr. T——.	61	Nov. 2, 1868.	Left.
3	Hospital.	William B——.	52	May 12, 1871.	Left.
4	Hospital.	Thomas M——.	68	Aug. 20, 1872.	Left.
5	Hospital.	Edmund B——.	67	May 7, 1872.	Left.
6	Hospital.	William H——.	64	July 17, 1873.	Left.
7	*Private.*	Mr. H——.	69	July 10, 1873.	Left.
8	Hospital.	Frederick D——.	38	Aug. 26, 1873.	Left.
9	Hospital.	Emma W——.	44	Jan. 12, 1874.	Left.
10	*Private.*—Mr. R. Phillips.	Mr. G——.	37	June, 1874.	Left.
11	*Private.*—Dr. Baber.	Mrs. B——.	56	Mareh, 1875.	Left.
12	*Private.*	Mr. P——.	45	July 30, 1875.	Left.
13	Hospital.	William M——.	44	Sept. 3, 1875.	Left.
14	*Private.*—Drs. Huddard and Habershon.	Mr. B——.	52	Mareh, 1876.	Right.
15	*Private.*—Dr. Owens.	Mr. S——.	37	Aug. 14, 1877.	Left.
16	Hospital.	Eliza C——.	56	Jan. 9, 1877.	Left.
17	Hospital.	William T——.	54	Aug. 15, 1877.	Left.
18	Hospital.	Michael S——.	55	April 4, 1879.	Left.
19	*Private.*—Dr. Gorham, Tunbridge.	Miss H——.	52	Nov. 30, 1880.	Left.
20	Hospital.	Arthur le G——.	62	Nov. 22, 1881.	Left.
21	*Private.*—Dr. Deeping, Southend.	Mr. S——.	64	Feb. 10, 1882.	Left.
22	*Private.*—Mr. E. Wright.	Mr. H——.	64	April 26, 1882.	Left.
23	*Private.*—Mr. W. Burton.	Mr. H——.	47	June 25, 1882.	Left.
24	*Private.*—Dr. May of Maldon.	Mrs. ——.	51	Oct. 18, 1882.	Left.
25	Hospital.	Eliza H——.	55	Dec. 5, 1882.	Left.
26	*Private.*—Dr. Neumann.	Mr. A——.	52	Aug. 22, 1883.	Right.

Analysis of the Twenty-six Cases.—19 in males, 7 in females. Average age, $53\frac{3}{7}$ years. Average age of men, $54\frac{1}{3}$; of women, $51\frac{5}{7}$. Twenty-four of the cases were on the left side and 2 on the

Propositions.

1. That in all cases of cancerous stricture of the rectum or colon, including the annular—which are not amenable to lumbar *colectomy* or anal excision—right or left lumbar colotomy is strongly to be advocated, with the well-grounded hope of relieving suffering, retarding the progress of the disease, and of prolonging life even for five or six years.

2. That lumbar colotomy is valuable as a *curative* operation in syphilitic and simple ulcerations of the bowel which resist other treatment, including cases of recto-vesical fistula, and that it is remedial in examples of volvulus of the sigmoid flexure, as well as of obstructions caused by tumors.

3. That to secure these advantages, it is necessary for the operation to be performed before the pernicious effects of obstruction occur.

I trust this material will help to place the operation of lumbar colotomy in the position to which it is entitled.

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that Died within the Month ("Too Late Cases").

Disease for which Operation was performed.	Result.	No.
Annular stricture of rectum. Obstruction complete for 6 weeks.	Sank. Died on 12th day, greatly relieved.	1
Cancerous stricture of rectum. Symptoms 2 years.	Sank on 2d day.	2
Epithelioma of anus and rectum of 6 years' growth.	Died on 21th day. Sank; operation wound healed. P. M.—Cancer of viscera.	3
Cancerous stricture of rectum. Symptoms 2 years.	Sank on 3d day. P. M.—Large cancerous mass in pelvis.	4
Cancerous stricture of rectum. Severe symptoms 8 months.	Sank on 6th day. P. M.—Disease quite local.	5
Cancerous stricture of rectum. Symptoms 2 years, blood for months.	Sank on 3d day. Peritonitis; bowel had ruptured above the stricture.	6
Cancerous stricture of rectum. Obstruction complete for weeks.	Sank on 20th day.	7
Increasing obstruction for 6 years. Recto-vesical fistula for months.	Sank on 10th day. Cancerous ulcer into bladder, with secondary growths.	8
Cancerous stricture, with symptoms for 5 years. Obstruction for 5 months.	Sank on 3d day. Peritonitis; cancerous ulcer between the rectum and jejunum.	9
Cancerous stricture of rectum of many months' standing.	Sank on 4th day.	10
Chronic obstruction complete.	Sank on 7th day.	11
Cancerous stricture of rectum.	Sank on 3d day.	12
Cancerous disease of rectum, with fecal fistula 9 months.	Sank on 3d day. Peritonitis. P. M.—Bowel above stricture ruptured.	13
Annular stricture of transverse colon. Symptoms 1 year, obstruction 4 weeks.	Sank on 10th day. P. M.—Confirmed diagnosis.	14
Cancerous stricture of rectum of slow contraction.	Sank on 5th day.	15
Cancerous stricture of rectum. Symptoms 3 or 4 years. Blood.	Sank on 3d day. P. M.—Cancer in viscera and peritoneum.	16
Cancerous stricture of rectum. Pain, blood, and mucus, with feces, for 8 years.	Died on 18th day suddenly, from sudden pain, collapse, and ruptured spleen. No peritonitis.	17
Cancerous stricture of rectum. Nine months.	Sank on 23d day. P. M.—Peritoneal cancer and volvulus of sigmoid flexure.	18
Cancerous stricture of rectum many months. Obstruction 3 weeks.	Sank on 3d day.	19
Cancerous stricture of rectum. Bleeding for 18 months.	Sank on 4th day. P. M.—Peritonitis and much cancer.	20
Cancerous stricture of rectum.	Sank on 5th day.	21
Cancerous stricture of rectum.	Sank on 5th day.	22
Cancerous stricture of rectum.	Sank on 5th day.	23
Cancerous stricture of rectum.	Sank on 5th day.	24
Cancerous stricture of rectum and vagina 15 months.	Sank on 27th day.	25
Stricture of rectum.	Sank on 4th day.	26

right side. Eighteen of them died in the first week, 3 in the second week, 2 in the third week, and 3 in the fourth week.

TABLE II.—Cases of Lumbar Colotomy

No.	Hospital or Private Patient.	Name of Patient.	Age.	Date of Operation.	Colotomy Right or Left.
1	Hospital.	James W——.	39	July 31, 1868.	Left.
2	Hospital.	Martha P——.	57	May 31, 1870.	Left.
3	*Private.*	Miss B——.	18	Sept. 6, 1871.	Right.
4	Hospital.	Eliza B——.	38	Oct. 10, 1871.	Left.
5	Hospital.	Richard C——.	46	Jan. 9, 1872.	Left.
6	*Private.*	Mrs. B——.	24	Feb. 10, 1872.	Left.
7	Hospital.	George S——.	56	April 14, 1873.	Left.
8	*Private.*— Dr. Stillwell and Sir W. Gull.	Mrs. B——.	72	Dec. 6, 1874.	Right.
9	*Private.*— Dr. Brown, Ealing.	Mr. R——.	64	June 2, 1876.	Left.
10	*Private.*— Mr. T. Harries, Aberystwzth.	Mr. T. D——.	57	Feb. 12, 1877.	Left.
11	*Private.*— Drs. Chambers and Menzies.	Mr. A——.	57	Dec. 30, 1876.	Left.
12	*Private.*— Mr. Hodgson, Brighton.	Mr. B——.	54	April 16, 1878.	Left.
13	*Private.*— Dr. Drewry.	Mrs. B——.	56	Mar. 4, 1878.	Left.
14	*Private.*— Dr. Wallace.	Mr. S——.	42	June 13, 1878.	Left.
15	Hospital.	John B——.	39	June 27, 1878.	Left.
16	Hospital.	George W——.	51	Nov. 12, 1878.	Left.
17	*Private.*— Dr. Bowes, Herne Bay.	Mr. S——.	64	April 5, 1879.	Left.
18	*Private.*— Dr. Kiddle, Leamington.	Mr. H——.	66	Nov. 8, 1879.	Left.
19	Hospital.	Mary T——.	59	Dec. 9, 1879.	Left.
20	Hospital.	Aliee P——.	25	Aug. 6, 1880.	Left.
21	Hospital.	Eliza C——.	29	Feb. 3, 1880.	Left.
22	*Private.*— Dr. Andrews.	Mr. W——.	42	Nov. 15, 1880.	Left.
23	Hospital.	Emma R——.	38	Nov. 61, 1880.	Left.
24	*Private.*— Mr. J. Burton and Dr. Higgens.	Mrs. S——.	42	April, 1881.	Left.
25	Hospital.	Charles H——.	64	June 18, 1881.	Left.
26	Hospital.	Samuel Robinson.	15	Dec. 30, 1881.	Left.
27	Hospital.	John James.	60	Feb. 15, 1881.	Left.
28	Hospital.	Eliza W——.	46	Feb. 4, 1881.	Right.
29	Hospital.	Sarah A——.	33	Nov. 2, 1881.	Left
30	Hospital.	Richard H——.	62	Feb. 10, 1882.	Left.
31	Hospital.	Daniel S——.	39	May 12, 1882.	Left.
32	*Private.*— Dr. Bailey.	Mr. S——.	35	July 28, 1882.	Left.
33	*Private.*— Dr. Calthrop.	Mr. T——.	62	Mar. 16, 1882.	Left.
34	Hospital.	John C——.	52	April 8, 1884.	Left.

Analysis of the Thirty-four Cases, or 56 per cent.—9 died within 6 months, 7 lived from 6 to 12 months, 9 lived from 1 to 5 years, 1 was alive 5 years after, 8 left the hospital convalescent;

for Cancer that Recovered from the Operation.

Disease for which Operation was performed.	Result.	Survived Operation.	No.
Cancerous stricture of rectum. Symptoms 3 years.	Convalesced. Died of abdominal cancer.	18 months.	1
Cancerous stricture of rectum.	Convalesced in 7 weeks.	Left hospital.	2
Annular stricture of rectum.	Convalesced. Died of internal cancer.	9 months.	3
Supposed cancer of rectum. Symptoms 18 months. Blood and mucus.	Convalesced.	Alive 5 years subsequently.	4
Cancer of recto-vesical septum.	Convalesced.	Left hospital.	5
Extensive rectal ulceration, supposed to be cancer and stricture.	Convalesced. Sank.	33 months.	6
Cancerous stricture of rectum and anus, with fecal fistula.	Convalesced. Sank. Much local cancer, no visceral.	10 months.	7
Colloid cancer of rectum and sigmoid flexure.	Convalesced. Sank later from disease.	21 months.	8
Cancerous stricture of rectum, with recto-vesical fistula, 3 months.	Convalesced. Sank.	3½ months.	9
Cancerous stricture of rectum. Symptoms 1 year. Bleeding 6 months.	Convalesced. Sank.	16 months.	10
Cancerous stricture of rectum 2½ years. No solid feces for 1½ years.	Convalesced. Sank.	4 months.	11
Cancerous stricture of rectum 1 year.	Convalesced. Sank.	7 months.	12
Cancerous stricture of rectum, with profuse hemorrhage. 1 year.	Convalesced. Sank.	12½ months.	13
Cancerous stricture of rectum, with fecal fistula many months.	Convalesced. Sank.	12 months.	14
Cancerous stricture of rectum. Symptoms 16 months.	Convalesced. Died of stricture of urethra (?).	10 months.	15
Cancerous stricture of rectum. Symptoms 2 years. Great obstruction.	Convalesced. Sank.	9½ months.	16
Cancerous stricture of rectum. Symptoms 1 year.	Convalesced. Died of apoplexy.	41 months.	17
Cancerous stricture of rectum. Symptoms about 1 year.	Convalesced. Sank. Internal cancer.	26 months.	18
Cancerous stricture of rectum 9 months.	Convalesced.	Left hospital.	19
Colloid cancer of rectum.	Convalesced. Died from perforation of growth into peritoneal cavity.	5 weeks.	20
Cancer of rectum. Symptoms 6 months.	Convalesced in 5 weeks.	Left hospital.	21
Cancerous stricture of rectum. Symptoms 6 months. Obstruction 2 weeks.	Convalesced. Sank.	3 months.	22
Epithelioma of rectum and anus 2 years.	Convalesced. Sank.	13½ months.	23
Cancerous stricture of rectum. Obstruction 3 months, complete 2 weeks.	Convalesced. Sank. Visceral cancer.	15 months.	24
Cancerous stricture of rectum. Symptoms 6 months.	Convalesced.	Left hospital.	25
Cancerous stricture of rectum. Symptoms 5 months.	Convalesced. Sank.	3½ months.	26
Cancerous stricture of rectum. Symptoms 25 years. Blood, mucus, and increasing difficulty of defecation.	Convalesced.	Left hospital.	27
Cancerous disease of rectum. Symptoms 9 months.	Convalesced. Died from extension of local disease.	6 weeks.	28
Cancerous disease of rectum. Symptoms 2 years. Blood and pain.	Convalesced. Died suddenly. Much local disease.	30 days.	29
Cancerous stricture of rectum.	Convalesced in six weeks.	Left hospital.	30
Cancerous stricture of rectum. Symptoms 6 months.	Convalesced. Sank.	10½ months.	31
Cancerous stricture of rectum.	Convalesced. Sank.	6 months.	32
Cancerous stricture of rectum.	Convalesced. Sank.	6 months.	33
Cancerous stricture of rectum.	Convalesced in 1 month.	Left hospital.	34

21 occurred in males; 13 in females; 31 were on the left and 3 on the right side. Average age, 44; of men, 46; of women, 41.

TABLE III.—Cases of Colotomy for Simple or

No.	Hospital or Private Patient.	Name of Patient.	Age.	Date of Operation.	Colotomy Right or Left.
1	Hospital.	Eliza O——, married, 2 children, 4 stillborn, 1 miscarriage.	29	Mar. 19, 1872.	Left.
2	Hospital.	Louisa C——.	33	Dec. 5, 1867.	Left.
3	Hospital.	Mary S——, married, no children.	46	Mar. 3, 1876.	Left.
4	Hospital.	Hans K——, been abroad, but not had dysentery.	65	Dec. 30, 1881.	Left.
5	Hospital.	Eliza B——, married, 1 child, 1 miscarriage.	42	Feb. 6, 1883.	Left. Bowel torn across.
6	Hospital.	Harriet K——.	37	Nov. 28, 1877.	Left.
7	Hospital.	James R——.	49	Nov. 14, 1882.	Left.

Cases of Lumbar Colotomy for Non-cancerous

8	Hospital.	William D——.	46	April 5, 1867.	Left.
9	*Private.*— Dr. Habershon.	Robert R——.	46	July 5, 1870.	Left.
10	Hospital.	Mary L——.	38	Aug. 12, 1873.	Left.
11	Hospital.	Mary P——, married, no children, no miscarriage.	37	Nov. 9, 1881.	Left.
12	Hospital.	William H——, no syphilis.	27	Nov. 7, 1881.	Left.
13	Hospital.	Philip K——.	35	Dec. 2, 1882.	Left.
14	Hospital.	Caroline H, married, had miscarriages.	28	May 10, 1878.	Left.
15	Hospital.	William E——, syphilis 3 years.	25	July 12, 1878.	Left.
16	Hospital.	Susan S——, married, had miscarriages.	40	May 3, 1881.	Left.
17	Hospital.	Louisa P——, married, 1 child, 1 miscarriage, had syphilis.	24	Sept. 2, 1874.	Left.
18	*Private.*— Sir W. Gull.	Mr. T——.	64	Mar. 16, 1869.	Left.
19	*Private.*— Mr. R. Phillips.	Mr. S——.	46	Nov. 14, 1877.	Left.
20	Hospital.	John S——.	38	July 16, 1880.	Left.
21	Hospital.	Fred. R——.	18	Mar. 2, 1874.	Left.
22	*Private.*— Mr. R. Phillips.	Mrs. M——.	46	April 5, 1870.	Left.

Analysis of Twenty-two Cases not Cancerous.—19 for stricture and ulceration of the rectum not cancerous, 1 for obstruction from volvulus of the sigmoid flexum, 2 ditto from pelvic tumors; 10 of the 19 cases of stricture occurred in females, 9 in males. Average age of 19 cases, 40 years; of

Syphilitic Stricture of Rectum that Died within the Month.

Disease for which Operation was performed.	Result.	Survived Operation.	No.
Syphilitic stricture of rectum. After last child, two years ago, had bowel trouble, which soon gave rise to fecal, vaginal, and perineal fistulæ.	Sank. P. M.—Good repair in loin: rectum almost obliterated from cicatricial bands.	On 13th day.	1
Chronic ulceration of rectum, with increasing obstruction for months.	Sank. P. M.—Sigmoid flexure, rectum and uterus all matted together; bowel very narrow and thickened.	On 4th day.	2
Very narrow stricture from 1 inch above anus; blood, mucus, and pain for months, with increasing obstruction.	Sank. P. M.—Extreme ulceration of rectum from 2 inches above anus, with sinus.	On 3d day.	3
Admitted with recto-vesical fecal fistula of 6 weeks' standing; 12 years before this patient had for weeks passed wind with his water, from which he had recovered.	Sank. P. M.—Marked signs of old ulceration and contraction of rectum; sign of old cicatrix into bladder, with recent fistula.	On 17th day.	4
Cicatricial stricture, with ulceration of 5 years' standing, commencing ½ inch from anus.	Sank. P. M.—Bowel very ulcerated and friable up to colon: it had been torn through at operation.	On 4th day.	5
Very narrow stricture and ulceration after 6 months' symptoms.	Convalesced. Died of phthisis. Bowel repaired; one stricture 3 inches, and a second 6 inches, from anus.	28 days.	6
Stricture and ulceration. Much pain and blood for 6 months.	Sank. P. M.—Colon much ulcerated; bowel contracted.	30 days.	7

Stricture or Disease that Convalesced after Operation.

Recto-vesical fecal fistula, with rectal obstruction and ulceration.	Convalesced. Died of kidney disease. Rectum repaired and contracted.	5 months.	8
Recto-vesical fecal fistula, with obstruction.	Convalesced.	14 years, alive and well.	9
Stricture of rectum after ulceration for 6 years. Much bleeding.	Convalesced. Died of kidney disease. Rectum healed and contracted.	34½ months.	10
Rectal symptoms for 15 years. Pain, blood, mucus with feces. Admitted with narrow stricture, probably syphilitic.	Convalesced. Sank from kidney disease and large spleen: lower 3 inches of rectum, lost its mucous membrane with cicatricial tissue outside.	40 days.	11
Stricture and ulceration of rectum 17 months. Blood and mucus with feces.	Sank.	18 weeks.	12
Stricture and ulceration of rectum. Symptoms two years.	Convalesced. Bowel healed and almost closed.	18 months, well and comfortable.	13
Syphilitic stricture and ulceration 30 months. No solid feces passed for 6 months.	Convalesced. Died from bronchitis.	1 year.	14
Very narrow stricture, 1½ inches above anus. Symptoms for 2 years.	Convalesced. Bowel had healed and almost closed 2 years later.	2½ years later alive and well.	15
Admitted with narrow stricture and vaginal and perineal fecal fistula. No history of syphilis.	Sank. P. M.—Rectum greatly indurated, contracted, and ulcerated; ulcers vertical.	9 weeks.	16
Admitted with recto-vaginal fecal fistula and fistula in buttock. Operation performed for relief.	Died of hip disease. All the fistulæ had closed soon after operation. P. M.—Lower 4 inches of rectum covered with bands of cicatricial tissue much contracted.	4½ months.	17
For vesico-rectal fecal fistula.	Rapidly convalesced. No feces passed after operation through rectum. Died of ruptured heart. P. M.—Rectum healed: old fistula into bladder small.	5½ years.	18
Multiple-rectal fibrous polypoid growths of 3 years' standing. Had had polypi removed twice before. Great tenesmus and discharge of blood and serum. At once relieved by the operation.	Convalesced, and died from pneumonia.	41 months.	19
Complete obstruction for 6 weeks. Operation to save life. Case, one of *volvulus* in all probability.	Convalesced.	4 years, alive and well.	20
Cancerous pelvic tumor occluding rectum.	Sank from the disease relieved.	7 weeks.	21
Pelvic tumor obstructing rectum (cancerous).	Relieved by operation. Died from ruptured cancerous mesenteric tumor.	4 days.	22

females, 35: of males, 45. All operations on left loin. Nine died within the month; 5 within 6 months; 4 lived respectively 1 year, 3, 3½, and 5½ years, Four are now alive and well, 1½, 2½, 4 years, and 14 years after the operation.

Analysis of the Whole Number of Eighty-Two Cases of Colotomy.

60 were performed for cancerous stricture.
19 " " " stricture and ulceration of the rectum not cancerous.
1 was performed for volvulus of the sigmoid flexure of the colon.
2 for obstruction due to pelvic tumors.

Side operated upon:

Left lumbar colotomy was performed in 77 and right lumbar colotomy in 5 of these cases, all of the 5 being cancerous. Right lumbar colotomy was called for in 1 out of 12 cases of cancerous stricture.

Duration of life after the operation:

26, or 43 per cent., of the cancerous, and 6, or 31.5 per cent., of the non-cancerous, cases, with 1 of the cases operated upon for obstruction, or 40 per cent. of the whole number of 82 cases operated upon, died within the month.

34, or 56 per cent., of the cancerous, and 13, or 68.5 per cent., of the non-cancerous, cases, with the case of volvulus and 1 of the cases of obstruction, or 60 per cent. of the whole number of cases operated upon, received more or less fully the benefit of the operation.

Of the forty-nine successful cases—

16	cases, 9	cancerous and	7	non-cancerous, died within 6 months.
8	" 7	"	1	" lived from 6 to 12 months.
12	" 9	"	3	" lived from 1 to 5½ years.
5	" 1	"	4	" were alive from 1½ to 14 years after operation.
8	" 8	"		had left the hospital convalescent.
49	34		15	

Sex:

Of the 60 cancerous cases, 40 were in males, 20 in females.
" 19 non-cancerous, 10 " 9 "
" 1 case of volvulus, 1 was in male.
" 2 cases of obstruction, 1 " 1 in female.
Of the 82 cases, 52 were in males, 30 in females.

Cancerous stricture is more frequent in males. Non-cancerous stricture is found equally in both sexes.

Age:

The average age of the cancerous cases,
When fatal, was 53; in male subjects 54, in female 51.
" successful, was 44; " 46, " 41.

The average age of the successful was about ten years less than that of the fatal cases.
No abnormality as to the position of the colon was met with in any of the 82 cases.

Excision of the Pylorus.

This operation was first performed for cancer by Péan of Paris in 1879, and Billroth, Wölfler, Nicolaysen, Czerny, Southam, and others have repeated it with enough success to justify its repetition in cases in which the diagnosis is tolerably certain and the disease movable. Full details of this difficult and dangerous proceeding are to be found in Billroth's *Clinical Surgery*, published by the New Sydenham Society (1882).

On Tapping the Intestine.

The practice of tapping the intestine with a fine trocar and canula in cases of intestinal obstruction is one which deserves serious consideration, since there is good reason to believe that a small puncture may often be made into a distended intestine and wind drawn off without any extravasation of the contents of the bowel taking place, and that if the distension of the strangulated, twisted, or otherwise obstructed bowel can be relieved by the operation there is some ground for hope that natural efforts may then release the bowel from beneath its band or from some internal peritoneal ring, and that even a twisted bowel may untwist. The operation, however, is not without its risk, as I have on several occasions known fecal extravasation to follow the practice, and Coupland and Morris quote other cases. I have been also led to believe that even in a large hernia its strangulation might be relieved by a like operation and a natural reduction take place, for a strangulated bowel, outside as well as inside the abdominal cavity, is damaged by the distension of the intestine itself more than from any extra-intestinal influence; and

if this distension can be relieved by simply drawing off the contents of the bowel by means of a very fine trocar and canula, the walls of the intestine would collapse, strangulation cease, and, unless adhesions confined the bowel in its position, its return might be looked for by natural efforts. These remarks are based upon the fact that intestine may be so treated without any extravasation following; and such a result actually came before me in a case of ileo-colic scrotal hernia in a gentleman act. 76, when, to enable me to reduce the bowel, I was driven to puncture the protruding intestine in four or five places, and, although much manipulation followed this practice, no extravasation occurred at the time or after, and a rapid recovery ensued without a drop of suppuration. The case occurred in the practice of Mr. Kelson Wright of Kennington. These remarks are only to be read as suggestions, and more particularly as applied to large umbilical and scrotal hernia. Since the introduction of the pneumatic aspirator by Dr. Dieulafoy this practice has received much encouragement. For more detailed evidence on the subject of intestinal obstruction and its treatment, the following papers may be referred to:

Brinton, *Croonian Lectures*, 1859.—Fagge, *Guy's Reports*, 1868.—Gay, *Trans. Lond. Med. Soc.*, 1861, 1862.—Gorham, *Guy's Reports*, vol. iii., series 1.—Hinton, *Association Med. Journal*, 1853.—Smith, *American Journal of Med. Science*, 1862.—Bryant, *Med. Times*, 1872.—*A Treatise on the Pneumatic Aspiration of Morbid Fluids*, by Dr. George Dieulafoy, 1873.—Trousseau's *Clinical Medicine*.—Hutchinson, *Med. Chir. Trans.*, vol. lvii., 1874.—Coupland and Morris, *Brit. Med. Journ.*, January 26, 1878.—Bryant, *Lancet*, May, 1878.—*Clinical Society*, 1878.—*Med.-Chir. Trans.*, 1882.

On Tapping the Abdomen.

Whenever fluid collects in the abdominal cavity so as to interfere with life's functions, the operation of tapping may be called for. It may be for *ascites*, a collection of fluid in the peritoneal cavity; for *ovarian dropsy*, a collection of fluid in a single or in a polycystic tumor; or for *hydatid*, whether hepatic, pelvic, or peritoneal. It may also be called for in *renal* or *splenic* cysts.

It would be out of my province to enter minutely into the diagnosis of all these conditions, as the majority of such cases come under the care of the physician, the surgeon being called in simply to operate. Nevertheless, it may be as well to give some of the leading points of diagnosis, for I need scarcely say that the operating surgeon is not relieved of all responsibility of diagnosis by the fact that a medical man has charge of the case. The operator, as such, assumes part, at least, of the responsibility of the case as well as of the operation.

Diagnosis.—In a general way it may be asserted, therefore, that *ascites* is the result of a chronic action that has been going on for some time, arising from liver, peritoneal, heart, or renal disease, the abdominal dropsy being one of the results only. The history of the case, consequently, will be a great help in arriving at a conclusion. The fluid, moreover, will be found to fill the abdominal cavity equally, fluctuation being perceptible across the abdomen and from before backward well into the loins, even when the abdomen is resonant. As a rule, the intestines will be found floating upward, thus giving resonance on percussion, the position of the bowels being influenced by that of the patient. With the body horizontal, they will give resonance at the umbilicus; with the pelvis depressed, above this point; with the pelvis well raised, resonance may even be detected near the pubes. In almost all these cases the sound over the loins will be dull. On looking at the abdomen the surface will be found smooth and the enlargement equal. The subject of diagnosis of ovarian and uterine disease will receive attention in Chapter XXVII.

Operation.—The instruments required for the operation are a moderate-sized trocar and canula, an india-rubber tube about six feet long adapted to a silver tubular plug that fits the canula when the trocar is removed, a lancet or small scalpel, a pad of lint, and a roll of good strapping.

Some surgeons prefer one of the modern instruments by which the india-rubber tube is attached to the canula at right angles, and they are very good; but those I have named are efficient.

The patient should be brought to the edge of the bed and placed in the recumbent position, with the shoulders raised, a folded sheet or piece of mackintosh cloth having been previously so arranged as to protect the sheets. A catheter should first be passed; then, with the trocar and canula warmed and oiled and a pail at hand, into which the end of the india-rubber tube is allowed to hang, the surgeon may with a lancet make a small incision through the skin and soft parts, about three inches below the umbilicus or at any other spot at which the operation is to be performed. He should next introduce the

trocar and canula with a direct force and semi-rotatory movement of the wrist, and, with his forefinger fixed about one inch from the end of the canula, guard against inserting the trocar too far. The abdomen having been punctured, the trocar may be removed with the right hand, the canula being pushed farther in at the same moment with the thumb, and its orifice plugged at once with the left thumb, to prevent the escape of fluid. The silver plug of the india-rubber tube may then be introduced and the fluid allowed to escape, the distal end of the tube being kept submerged in the fluid in the receptacle, the tube acting as a syphon.

To facilitate the flow and to evacuate the whole contents of the cavity, some surgeons roll the patient over on the side or place him so at the first, but such a proceeding is unnecessary.

When the fluid has ceased to flow, the canula is to be gently removed, the thumb and finger of the left hand nipping up the soft parts as its end appears, so as to prevent the admission of air into the abdominal cavity and the trickling of any fluid down the patient. The edges of the wound may then be adapted by a piece of good strapping, and a pad of lint applied when oozing appears, but not otherwise; two or three bands of strapping three inches wide should then be adjusted to the front of the abdomen from side to side. Where great hollowness is left, a pad of cotton-wool often gives comfort. The old-fashioned flannel bandage may be abolished, as it is only an inconvenience.

All pressure on the abdomen during the flow of the fluid should be avoided as unnecessary, and also all pressure after the operation, support only being required.

The usual place to perform the operation is in the linea alba, about two or three inches below the umbilicus; but in ovarian disease any point in the linea semilunaris may be opened, and in rare cases any other.

When a hydatid, renal, or splenic cyst requires to be tapped, a small trocar and canula, such as is employed for tapping a hydrocele, should be used, though in these cases the pneumatic aspirator is of great service, for by its use the fluid can be removed without the possibility of air being introduced.

Hydatid Tumors

of the liver, spleen, or other parts of the abdomen are occasionally met with, and, however large a size they attain, they rarely produce other symptoms than those mechanically caused by their size; and on that account they may require treatment. Their origin is indicated by their position, although, when situated in the pelvis, there may be an impossibility in diagnosing them from ovarian cysts. They are almost always very globular and tense, and rarely give rise to distinct fluctuation. The external feel of a hydatid is somewhat peculiar and characteristic. In 1868, I removed, with permanent success, an enormous hydatid tumor from the abdomen, although apparently not from its cavity, of a lady-patient of Dr. Oldham, æt. 35, who was believed to have had ovarian disease (*Guy's Hosp. Rep.*, 1868), while Sir Spencer Wells records a case in which the hydatids were turned out of the abdominal cavity. Sometimes the hydatid dies without surgical interference, and, as a consequence, severe suppuration is set up, with violent constitutional disturbance, which requires surgical aid.

Not long since I opened with marked success a large abscess over the liver of a boy æt. 17, and evacuated a quantity of pus bearing the peculiar odor of hydatid pus. The abscess clearly came from the liver and was a suppurating hydatid. The boy previously had suffered from tapeworms. In 1869, I had to open freely a suppurating hydatid tumor which half filled the abdomen of a gentleman æt. 40 who had had it tapped some months before in Australia, and a complete recovery ensued. A quantity of dead hydatid cysts escaped through a large canula that was introduced. The cyst was washed out daily with great benefit. This gentleman is now quite well. I have had at least ten other cases in which a like treatment was employed with success, nor have I lost one, although several have had a very narrow escape. The secret of the treatment of suppurating hydatid cysts consists in a free outlet for all purulent and dead hydatid deposits and the frequent washing out of the suppurating cavity with water containing iodine, Condy's fluid, carbolic acid, or creosote, with or without the introduction of a drainage-tube or elastic catheter. For the operation a large trocar and canula should be employed, the canula being left in for some days until a good opening is established; it may then be exchanged for an elastic catheter or large drainage-tube.

Before suppuration takes place, however, other treatment is applicable, such as draining off partially or wholly the fluid contents of the hydatid by means of a very fine trocar

and cannula. I have performed this operation on many occasions with success, but generally prefer to draw off only a few ounces of the fluid, clinical experience indicating that by this measure alone the hydatid may be killed, subsequently withering up and ceasing to hurt. Dr. J. Miller of Tasmania, where this disease is frequent, speaks highly of the use of twenty-grain doses of the bromide of potassium three times a day after the tapping, and Dr. Bird of Melbourne combines with it drachm doses of the tincture of kamela. At times, also, cases which have been looked upon as cured are not so, and after the lapse of years the disease reappears. When suppuration follows tapping, however, a cure ensues.

The operation of simply tapping a hydatid with even the finest instruments is not, however, free from danger, for in January, 1877, I tapped a man æt. 42 who, with the exception of the hydatid tumor of the liver, was in perfect health, and drew off half a pint of hydatid fluid, having to perforate the structure of the liver to the depth of an inch to reach the cyst. The operation was not attended by the slightest distress, but on the removal of the needle an agonizing pain attacked the man's face and jaws, accompanied with flushing of the head and neck. This was followed by vomiting, extreme pallor, and stertorous breathing for a minute, followed by death in two minutes. At the necropsy nothing was found to account for this sudden end—that is, there was no embolism or heart trouble, no brain disease, nothing but a large hydatid cyst behind the liver. The needle had, however, passed through a misplaced portal vein on its way to the hydatid, and the question arose as to the possibility of death being due to the mixing of the hydatid fluid with the venous blood. No blood was extravasated (*Clin. Society*, 1878). My colleagues, Dr. Fagge and Mr. Durham, have given us some evidence that a cure can be obtained by electrolytic treatment on Dr. Althaus's plan of introducing into the tumor two electrolytic needles, one or two inches apart, connected by means of wire to the negative pole of a galvanic battery of ten cells, and completing the current through the tumor by means of a moistened sponge attached to the positive pole of the battery, applied for ten or more minutes at a time to different points over the swelling (*Med.-Chir. Trans.*, vol. liv.). This operation may be repeated according to circumstances.

Such treatment may be employed when simple tapping fails to cure. Some of the patients reported as cured by these means have returned, however, with the disease; and it is still a question whether more is gained by this method than by simple puncture and the withdrawal of some of the hyadit fluid.

Further information may be gained from Murchison's work on the liver (1868); Harley's paper, *Med.-Chir. Trans.*, vol. xlix.; and the book by Dr. Bird of Melbourne.

Tumors of the Umbilicus.

Pedunculated outgrowths from the umbilicus are not uncommon, and are always found in children, being composed of simple granulation tissue; indeed, it seems probable that they are really due to excess of granulation growth from the point at which the umbilical cord separated. They sometimes attain a large size and have occasionally a slight central canal or orifice, though the former never travels far. I have seen one the size of the last joint of my little finger. They are easily cured by the application of a ligature to their bases.

These tumors, however, must not be confounded with a condition that is occasionally met with—viz., the presence of a fleshy outgrowth not unlike a glans penis, through which a real canal extends into the bladder, the canal being clearly an open urachus. I have seen two such cases; one I recorded in my Lettsomian lectures on the surgical diseases of children (1863). I wished to cauterize the surface of the canal and thus cause its contraction and closure, but was not allowed.

I have also seen a large hernial protrusion appear at the umbilicus, with the whole surface ulcerated, in which there were some solid contents, which I took to be the liver. It subsequently completely cicatrized, and a good recovery ensued. The drawing of this case is in Guy's Hospital Museum. (*Vide* Fig. 319.)

Sebaceous tumors, as well as accumulations of sebaceous matter, are also met with at the umbilicus in dirty people. I have turned out large masses of such indurated secretion from the cuplike depression.

Cancerous tumors, etc., as well as simple warty growths and syphilitic condylomata, may also exist in the same position.

CHAPTER XV.

HERNIA.

Diagrams illustrating the Different Forms of Hernia, with some of its Complications.

In all these diagrams the thick black line represents the parietes covering in the hernial sac; the thin line, the peritoneum and hernial sac; the small body at the bottom of the sac, the testicle.

Fig. 292.

Fig. 292. This diagram illustrates the tubular vaginal process of peritoneum open down to the testicle, into which a hernia may descend. When the descent occurs at birth, the hernia is called "congenital;" when at a later period of life, the "congenital form," Birkett's "hernia into the vaginal process of peritoneum," or Malgaigne's "hernia of infancy."

Fig. 293.

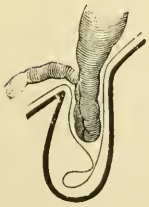


Fig. 293. The same process of peritoneum open halfway down the cord, into which a hernia may descend at birth or at a later period. Birkett's "hernia into the funicular portion of the vaginal process of the peritoneum."

Fig. 294.

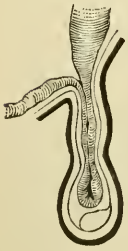


Fig. 294. The same process undergoing natural contraction above the testicle, explaining the hour-glass contraction met with in the congenital form of scrotal hernia, as well as in hydrocele.

Fig. 295.

Fig. 295. Diagram showing the formation of the "acquired congenital form of hernia"—the "encysted of Sir A. Cooper," "the infantile of Hey"—the acquired hernial sac being pushed into the open tunica vaginalis, which encloses it.

Fig. 296.

Fig. 296. Diagram illustrating the formation of the "acquired" hernial sac, distinct from the testicle or vaginal process of peritoneum which has closed.

Fig. 297.

Second variety of displaced hernia.

Fig. 297 illustrates the neck of the hernial sac pushed back beneath the abdominal parietes with the strangulated bowel. (*Vide* Fig. 312.) Bell's form.

Fig. 298.

Third variety of displaced hernia.

Fig. 298 shows the space in the subperitoneal connective tissue into which intestine may be pushed through a rupture in the neck of the hernial sac, the intestine being still strangulated by the neck. (*Vide* Fig. 314.)

Fig. 299.

Fourth variety of displaced hernia.

Fig. 299. Diagram showing how the neck of the vaginal process may be stretched into a sac placed between the tissues of the abdominal walls either upward or downward between the skin and muscles, muscles themselves, or between the muscles and the internal abdominal fascia, forming the intra-parietal, inter-muscular, or interstitial sac. Hernia *en bissac* of the French; "additional sac" of Birkett. (*Vide* Fig. 315.)

Fig. 300.

First variety of displaced hernia.

Fig. 300. Diagram illustrating the reduction of the sac of a hernia *en masse* with the strangulated intestine.

ABDOMINAL HERNIA.

Abdominal hernia or rupture signifies the protrusion of any viscus through an opening in the parietes of the abdominal cavity. This protrusion for the most part occurs at the *inguinal* and *femoral* canals or *umbilicus*, though occasionally at other parts when the abdominal walls have been weakened by some inflammatory, lesion, rupture, or division of muscle from injury or operation, and more rarely at such weak points of the abdominal walls as the obturator foramen, the perineum, the ischiatic notch, the diaphragm, or the vagina.

It is met with in subjects of every social condition, but most frequently amongst the so-called working classes, because "hernia occurs oftenest in the most numerous classes, and not in the most laborious."

Agnew tells us that in the American war 50 out of 1000 recruits were rejected on account of rupture; that in Germany the proportion was 82; in France, 65; in England, 39; in Ireland, 36; in Italy, 76.

Hereditary Tendency.—Hereditary predisposition to hernia is also doubtless a reality, since a third of all cases acknowledge a history of having a parent with rupture: and such predisposition probably exists as a general laxity of the mesenteric folds and parietal layer of peritoneum. I have been called upon to operate on an old gentleman the male branches of whose family for four generations—twelve in all—have been ruptured. Inguinal hernia is often due to a failure in the natural closure of the sheath of peritoneum that travels down with the descending testicle; which failure is more common on the right side.

Subjects who are congenitally feeble and others who become weak from illness or old age are more liable to hernia than the robust, the weakness of the abdominal parietes

yielding to the natural pressure of the abdominal contents under the influence of some sudden or prolonged muscular exertion. A large number of the cases of hernia are slow in their development, many are sudden, and in all muscular exertion plays an important part.

Proportion as to its Seat.—Out of every 100 cases of hernia, 84 are *inguinal*, 10 *femoral*, and 5 *umbilical*. It is more common in males than in females in the proportion of 4 to 1, 18,492 females only having been applicants for trusses at the Truss Society, out of the total of 96,886 (*Report*, 1871).

Hernia in Females.—*Females* are as liable to inguinal as they are to femoral hernia—to the inguinal in early life, from the canal of Nuck being open; to the femoral in middle and old age. In females under twenty years of age there are 87 cases of inguinal to 13 of femoral hernia, and after forty years there are 32 cases of inguinal to 68 of femoral. The largest number of cases of femoral hernia are developed during the child-bearing period of a woman's life—that is, between twenty and forty years of age. Prior to menstruation it is so rare as to be almost unknown. Kingdon gives only four such cases.

Hernia in Males.—In males *inguinal* hernia is the usual form, Kingdon's table showing that the largest number of cases occur during the first ten years of life, from a want of closure of the vaginal process of peritoneum that covers the spermatic cord. It is about half as frequent between the ages of ten and twenty years, while between twenty and forty it is as common as it is at the early period of life, but its frequency rapidly diminishes after that period.

Femoral hernia occurs in the male in about 4 in every 100, though it becomes, as in the female, relatively more common than inguinal as age advances. During the first ten years of life it is not met with more frequently than 1 in 300, whilst between the ages of ten and twenty, 2 per cent. are femoral; between twenty-one and forty, 4½ per cent.; between forty-one and 60, 6 per cent.; and above sixty, nearly 8 per cent.

Average Age when Strangulated.—The average age of persons suffering from *strangulated inguinal* hernia is forty-three, but from femoral fifty-five. A hernia that becomes strangulated in its first descent is far more acute and fatal than that which has been of long standing, and a femoral hernia is more liable to become so strangulated than an inguinal in the proportion of 3 to 1. These "recent cases" of femoral hernia mostly occur in old women about sixty years of age, and of inguinal in young men, the hernia being in the latter of the "congenital kind."

Anatomy of a Hernia.

A **hernial tumor**, with few exceptions, is composed of a *sac* with its *contents* and the soft parts covering it.

The *sac*, which is made up of peritoneum, is formed in two ways—*firstly*, by the gradual stretching and pouching of this membrane through an opening in the abdominal parietes by the protruding viscera, and, being artificial, has been well named by Birkett the *acquired hernial sac*, this variety being common to all forms of hernia; and *secondly*, of the open vaginal tubular process of peritoneum formed by the descent of the testicle, the opening that normally exists in fœtal life not having closed owing to some deficiency in the obliterating process that naturally commences at the internal ring and proceeds downward toward the testis in the scrotum, this variety—equally well named the *congenital hernial sac*—being found only in inguinal hernia.

The formation of the hernia in the former case is a gradual, but in the latter a rapid, process, the "acquired" hernia being an affection of middle and old age, the "congenital form" usually one of infancy or young adult life.

The sac is also composed of a body and a neck, which communicates by a mouth with the abdominal cavity. When the hernia is small, the neck and body appear as a small pouch, into and out of which the hernial contents pass with facility, the sac having no narrow neck by which the return of the intestine can be retarded; but when the hernial sac is large and has escaped into looser tissues, its body or fundus so expands as to render, by comparison, the neck of the sac a narrow canal or orifice, when the return of the hernial contents often becomes one of difficulty; indeed, it is under these circumstances that it frequently becomes strangulated.

The neck of the sac also undergoes changes which it is essential to understand, particularly in cases of scrotal hernia, where the peritoneum is so forced outward through the inguinal ring as to fall into puckered folds.

These folds will disappear, however, if the hernia and sac be reduced into the abdominal cavity or the constricting ring of tissue external to it be divided, the degree of unfolding of the neck of the sack being regulated by the amount of expansion of which it is capable. But should the sac be neither returned nor its constricting ring of outside tissue divided, the puckered folds of peritoneum will adhere, and probably the subperitoneal connective tissue will unite with it. The neck of the sac, under these circumstances, becomes indurated and thickened, and as time progresses contracts; as a consequence, a narrowing and rigidity of the neck of the sac ensue, which necessitates in old inguinal hernia, when an operation for strangulation is required, the opening of the sac and a free division of its neck.

When a hernia forms at the seat of a wound in the abdominal wall, there is no sac; and the same occurs when the cæcum or colon protrudes through the inguinal canal.

The **contents** of a hernia are usually small intestine and omentum, a portion of the last two feet of ileum being, as a rule, involved; the cæcum and colon also are occasionally so, and cases are on record in which the bladder, stomach, ovary, or gall-bladder has been found in the sac.

At times the omentum is so pushed before the intestine as to cover it completely, thus forming an inner sac; the bowel, as a rule, however, lies behind the omentum.

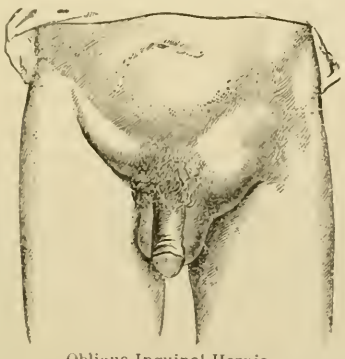
When intestine protrudes, the hernia is called an *enterocele*; when omentum, *epiplocele*; when both intestine and omentum occupy the sac, *entero-epiplocele*; when bladder, *cystocele*; when stomach, *gastrocele*, etc.

The tissues that cover in a hernial sac will necessarily depend upon the seat of the hernia. Thus, in the *umbilical* it may be only the membrane of the cord, skin, and abdominal fascia; in the *scrotal* it will be the scrotal tissues; in the *femoral*, the skin with the superficial and deep fasciæ; but in all, and more particularly in the femoral, the surgeon should bear in mind the anatomical fact that a layer of fascia, which lines the abdominal muscles and separates them from the peritoneum, covers in the true peritoneal sac, and is known as the "fascia propria" of Sir A. Cooper, and between this fascia and sac some subperitoneal fat often exists.

When a hernia comes down into a sac and goes up again, either by itself or aided by position or by the surgeon, it is called *reducible*; when it cannot be returned, it is called *irreducible*; when it is constricted sufficiently to interfere with the return of the contents of the protruding viscera, it is known as *incarcerated*, but would be better called *obstructed*; and when, in addition, the circulation of the part is interfered with, it is said to be *strangulated*.

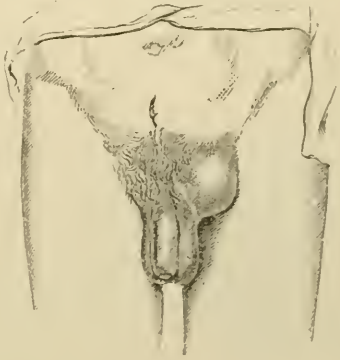
When the protrusion takes place *above* Poupart's ligament, through the internal ring, but does not traverse the canal sufficiently far to appear through the external ring, the

Fig. 301.



Oblique Inguinal Hernia.
Bubonocele on right side, but passing through external ring on left.

Fig. 302.



Direct Inguinal Hernia.

hernia is called a *bubonocele* (*vide* right side of Fig. 301); when it protrudes through the external ring into the scrotum, a *scrotal hernia* (*vide* left side of Fig. 301), both forms being included in the term *oblique inguinal hernia*.

When a hernia makes its way directly through the external ring without having passed down the inguinal canal, it is called a *direct inguinal* (Fig. 302).

A crural or femoral hernia is *below* Poupart's ligament, the protrusion having

come down through the crural ring on the inner side of the sheath of the femoral vessels (Fig. 303).

An **umbilical hernia** or exomphalos is a protrusion at the navel. A **ventral** is a protrusion at any other part of the abdomen. The names of every other form are according to the locality.

Symptoms.—A hernia in its early stage may show itself as a mere *fulness* about the internal inguinal ring, the crural ring, or other opening, this fulness becoming very manifest on the patient standing and coughing. The patient's attention has probably been drawn to the part by a feeling of *weakness* on making exertion or in performing any natural act demanding the strong action of the abdominal muscles. With this weakness there is often associated some griping abdominal pain or feeling of uneasiness—wrongly attributed to constipation—and in old people these symptoms should always attract the notice of the surgeon.

Fig. 303.

Femoral Hernia.

As the hernial pouch increases the tumor in the inguinal canal, at the femoral ring or umbilicus, will show itself as a distinct swelling, this being manifest when the patient stands or coughs, but disappearing on his lying down. It will, moreover, be prevented from returning on the patient assuming the erect posture if the finger of the surgeon is placed over the ring. The swelling always comes from above and travels downward. As the tumor still further increases a distinct impulse will be felt by the hand when placed over it if the patient coughs, and a peculiar gurgling sound will be heard on the application of pressure to the part to cause its reduction. The return of the bowel also into the abdominal cavity will be marked by the disappearance with a jerk of the contents of the sac and a distinct appreciation by the finger of the aperture through which it has passed.

"If the surface of the tumor be uniform: if it be elastic to the touch; if it become tense and enlarged when the patient is troubled with wind, holds his breath, or coughs; if in the latter case it feels as if it were inflated; if the part return with a peculiar noise and pass through the opening at once.—the contents of the swelling are *intestine*. If the tumor be compressible; if it feel flabby and uneven on the surface; if it be free from tension under the circumstances just enumerated; if it return without a noise and pass up gradually,—the case may be considered as *epiplocele*. If a portion of the contents slip up quickly and with noise, leaving behind something which is less easily reduced, the case is probably an *entero-epiplocele*" (Lawrence).

In infants, where Malgaigne's "hernia of infants" exists (Fig. 292), or Haller's "hernia congenita," both being caused by the descent of intestine into the open vaginal process of the peritoneum, the tumor is very often large when first discovered, and often scrotal. In young adults, where the same kind of hernia exists, the swelling comes suddenly and at once by one rush downward into the scrotum, this rush being accompanied with pain.

Treatment.—In all these forms of hernia, when reducible, either the *palliative* plan of treatment may be employed, or what is known by the *radical cure*.

The palliative treatment consists in the application of a *truss*—an instrument composed of a pad or cushion connected with a metallic spring or with straps, and so arranged that the pressure of the pad keeps the hernia from descending; the spring maintains the pad in position and at the same time allows perfect freedom of movement of the body. Any truss that accomplishes this is beneficial, but any that fails in this is worse than useless, as it is injurious and gives false confidence.

The operation for the **radical cure** of hernia will be considered under the heading "Inguinal Hernia."

Hydrocele of the Hernial Sac

is a very rare affection, and not more than six cases are on record. I have seen but one true example of it—that is, if the term be confined to such cases of accumulation of fluid in the hernial sac in which the neck of the sac is occluded by some adherent omentum or intestine or by the radical cure. The case occurred in a man æt. 40 who had been treated for hydrocele of the right testicle for twenty years, and had frequently been tapped. He came under my care with a right scrotal swelling which extended up to the internal ring,

and obscure symptoms of intestinal obstruction. He was tapped and serous fluid was drawn off, but the symptoms continued. After the lapse of two or three days, as the abdominal symptoms increased in severity in my absence, an exploratory operation was performed, and a mass of what was supposed to be omentum or an omental sac containing intestine was found blocking up the internal ring. This was opened and the mucous membrane of the bowel exposed. The opening into the bowel was stitched up, but the symptoms persisted; and the man died two days later, of peritonitis. An examination after death showed that what had been regarded as an hydrocele was a dropsy of a congenital hernial sac, and what had been opened as a mass of omentum or omental sac was a knuckle of ileum matted together and to the neck of the sac by lymph, this adhesion giving rise to the fatal obstruction. No hydrocele existed. Such cases as these should not be mistaken for dropsy or suppuration of the hernial sac after herniotomy, which are by no means unfrequent conditions, and should be treated by tapping or a free incision.

Irreducible Hernia.

When the contents of a hernial tumor cannot be returned into the abdominal cavity, an irreducible hernia is said to exist; and this condition may be temporary, brought about by anything that alters the relations between the bulk of the tumor and the neck of the sac or the opening through which they would have to return, such as some excess of feces or flatus in the part or some fresh descent of omentum or bowel. A hernia may be made permanently irreducible by adhesions between the sac itself and its contents, by bands traversing the sac, or by adhesions between the intestine and some fold of omentum. In long-standing herniæ the same result will ensue, from the development of fat in the omentum.

The tonic or spasmodic contraction of the structures outside the neck of the sac under the influence of irritation, as well as the induration of the neck of the sac itself or of the surrounding parts, has also an important influence in preventing the reduction of the tumor.

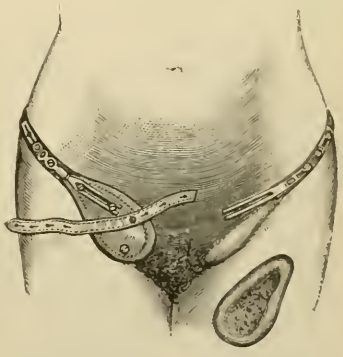
When the cæcum or large intestine forms the contents of the hernia, the rupture may be irreducible, from the fact that the peritoneum, which is naturally adherent to these parts and is dragged down with them, becomes fixed to the tissues into which it is protruded. A cæcal hernia is, however, always difficult of reduction. In one case I had to puncture the bowel with a trocar and canula and draw off the air it contained before I succeeded. No harm followed this step, and the patient did well; but the measure is not without its dangers.

Prognosis.—An irreducible hernia is always a source of anxiety and danger, because when composed of omentum a piece of intestine may at any time slip down behind it and become caught in one of its folds; and when composed of omentum and intestine, any accumulation of the contents of the bowel within the hernial sac may give rise to obstruction, and then strangulation of the hernia is not distant. An irreducible hernia, moreover, is always liable to injury.

An irreducible scrotal, or even femoral, hernia will sometimes attain a large size. I have seen examples of both reaching halfway down the thigh, but umbilical hernia will sometimes attain a still greater size.

These forms of hernia often give rise to dyspeptic symptoms, to irregularity of bowels and colicky pains; but the chief danger lies in their tendency to become strangulated.

Fig. 304.



Drawing showing on the *Right* Side a Truss fitted to an Irreducible Hernia, in which the Pad has been moulded upon a Cast of the Patient's Groin; and on the *Left* Side an Irreducible Hernia with the Hollow of the Pad exposed to View, prepared for Application.

Treatment.—A large irreducible *entero-epiplocele* must be treated by a bag truss—that is, with an instrument so adapted as to support the hernia and prevent, as far as possible, its increase. A small irreducible umbilical, inguinal, or femoral hernia ought to be treated by a hollow truss, the only reliable pad being one moulded upon a plaster cast of the hernia, taken when the tumor is at its smallest, after a day's rest. The pad should be made of metal moulded to the cast and lined with wash-leather (Fig. 304: *vide* paper by author, *British Medical Journal*, February 16, 1884). A *omental* hernia should be

treated by a truss made, in the way described, upon a cast. Every patient with an irreducible hernia should be warned against taking violent exercise or overdistending the abdominal viscera. The bowels should never be allowed to become constipated, and, above all, the slightest symptom of pain or increase of size in the tumor should be brought at once under medical advice, since these irreducible herniæ are treacherous things and become obstructed and strangulated very insidiously.

In many cases of irreducible hernia, and particularly in recent cases, reduction may be effected by rest in the horizontal posture, a brisk purge or enema, and the administration of small doses of saline purgatives, such as the sulphate of magnesia, so as to keep up a gentle action of the bowels, with the *local application of ice*, the diet being at the same time nutritious, though not of a bulky nature. In this way I have procured the reduction of cases of hernia that had been down for three months; in several cases I have succeeded after three week's treatment. Old irreducible herniæ are, however, rarely made reducible by treatment, but the not very old examples and the recent can generally be made reducible by the means already indicated.

Obstructed or Incarcerated Hernia.

The SYMPTOMS *of an obstructed hernia*, as of obstructed intestine, are not very definite, but the chief are obscure abdominal pains with a dragging sensation about the umbilicus after food, nausea, and at times vomiting. Constipation, when present, aggravates the symptoms and renders the *local signs* of obstructed hernia more marked, the tumor becoming distended, tympanitic, and painful. On manipulation, the intestine in the hernia may be partially or wholly emptied of its gaseous if not of its solid contents, and the compression of the tumor be accompanied by the peculiar gurgling sound of gas and fluid as these traverse the canal toward the abdominal cavity. When such symptoms are chronic, they are generally known as indicating an *incarcerated hernia;* but such a term is not satisfactory, it being applied to the obstructed as well as to the reducible hernia, and should be discontinued.

TREATMENT.—These cases require great care in their treatment, because, if neglected, they pass on rapidly to inflammation or strangulation. *Rest* in the horizontal position is of primary importance, and the tumor, if scrotal, should be slightly elevated. *Warmth* to the hernia also often gives comfort, relaxing the parts, and thus favoring reduction.

When constipation, *unaccompanied by vomiting*, exists, a brisk purge may be given; but with this symptom a purgative enema is to be preferred, the natural action of the bowels being stimulated by these means and the contents of the hernial sac moved on. The tumor itself should not be manipulated at this stage of the case, such a step doing harm by bruising or setting up inflammatory action. When success does not attend these efforts and the symptoms persist, the source of obstruction will have to be sought by the surgeon, as it will probably be mechanical, and the case have to be dealt with as one of strangulated hernia.

Inflammation of a Hernia.

An inflamed is not a strangulated hernia. Inflammation of a hernia is generally the result of some injury to an irreducible hernia, from either accident, a badly-fitting truss, or ill-advised manipulation. An irreducible hernia after an attack of obstruction may inflame. A reducible hernia, becoming temporarily irreducible and inflaming, may become permanently irreducible by adhesions forming between the sac and its contents.

The local *signs* of an inflamed hernia are pain, swelling, and induration. When the tumor contains omentum, it becomes nodulated and irregularly hard; and when intestine, much fluid will be poured into the sac. When the action is enough to interfere with the natural function of the tube, symptoms of general peritonitis or obstruction will appear, which must be dealt with on ordinary principles.

TREATMENT.—*Rest* and the *local application of ice* in a bag are the most important remedies, also *purgatives* when obstruction in the hernia does not exist, and opium when it does. By such means the symptoms are generally arrested; and when this result does not take place, the case passes on to one of obstruction, if not of general peritonitis.

Rupture of a Hernia,

or rather of the sac and integuments over it, has been recorded by B. Pitts of St. Thomas's Hospital (*Lancet*, April 7, 1883), and the accident, as proved by the case, is

not necessarily fatal. It occurred in a woman æt. 46 who had been operated upon for a strangulated *femoral* hernia two years and three months previously. She had not worn a truss for a year before the accident, and the hernia had become as large as a child's head. It burst during a fit of coughing, and the line of rupture was in the sound skin near the cicatrix; intestine at once protruded through the wound. After the lapse of three hours Mr. Pitts saw her, and found a stout woman much collapsed, with a foot and a half of small intestine, bruised, congested, dirty, and very cold, protruding through an external wound about one inch long. He cleansed the part with warm carbolic lotion, and after enlarging the skin opening returned the protruding bowel, and with it the cæcum and about five feet of small intestine that had been in the sac. He cut off redundant skin and sac and stitched up the part, making good provision for drainage. A good recovery ensued. A second case like the above is also recorded by Mr. Jones (*Lancet*, April, 1880).

Intestinal Obstruction and Peritonitis as a Result of the Adhesion of a Piece of Intestine to the Hernial Sac.

I published such a case in 1861 in Part III. of my *Clinical Surgery*, and Mr. Birkett, in his excellent article in *Holmes's Surgery* (third edition, vol. ii., 1883), has given a second case with a drawing, which I also had the advantage of seeing; and he alludes to the fact that M. Littré called the attention of the profession to the cases illustrated by the above in a paper, "Sur une nouvelle espèce de Hernie," *Mém. de l'Acad. Royale des Sciences*, 1700, p. 300. The notes of my case are as follows:

Umbilical Hernia; Obstruction to the Bowels from a Sacculated Adherent Colon; Death.—A woman æt. 56, having had a hernia for many years, was suddenly seized some twenty-four hours before her admission into Guy's, under the care of Mr. Cock, with symptoms of strangulation. The taxis, under the influence of chloroform, proved successful, but collapse and death followed in twelve hours. After death general peritonitis was found to have been present, the intestinal coils being all adherent. An umbilical omental hernia the size of a fist existed, the omentum forming a distinct sac. To the centre of this the anterior wall of the transverse colon was firmly adherent, forming a kind of pouch. The colon was, however, tolerably free. The intestines above this point were distended, and below it contracted and empty. The cæcum was of an enormous size, almost filling the lower part of the abdomen. It was here that the tension had been experienced; it was black and in places the peritoneal coat was fissured, leading to the belief that but little extra distension could have been borne without a rupture taking place. The mucous membrane was also lacerated transversely, while the walls were so thin that they were nearly ruptured in handling, these conditions being such as we commonly meet with in cases of chronic intestinal obstruction.

In this interesting case death had doubtless been caused by peritonitis, although not from the strangulation of the umbilical hernia, but from a partially-ruptured and over-distended cæcum—a condition of bowel which had clearly been produced by the traction exerted upon the transverse colon, the result of the adhesion of its walls to the omental sac.

As elucidating a secondary result of hernia this case must be regarded as most valuable, illustrating, as it does, a point not perhaps sufficiently recognized—namely, the influence of the adhesion of the bowel to a hernial sac or to the abdominal walls upon the functions of the intestines, since, doubtless, such adhesions are sufficient to account for many of the griping and painful symptoms which exist in an old and irreducible hernia, as in other cases of abdominal trouble. The case referred to must also be regarded as a good illustration of the result of a long-continued interference with the bowel's action, for the overdistension of the cæcum, with its attendant consequences, was apparently due entirely to the interference with its functions resulting from the union of the walls of the transverse colon with the omental sac. The calibre of the colon itself was not materially diminished, but its power of acting had become paralyzed; the greater the distension of the intestine above, the greater must have been the traction caused by the adhesion, and as a sequel the greater was the effect of this interference. At last complete paralysis of the part had taken place, and complete obstruction, giving rise to all the symptoms and conditions which had terminated in death.

These cases tend to prove that the smallest traction of a portion of the calibre of the intestine in hernia or elsewhere, although accompanied with an open passage of the bowel, is quite sufficient to interfere with the bowel's action, and even to cause complete obstruction. In a former page I have pointed out how strangulation of the bowel within

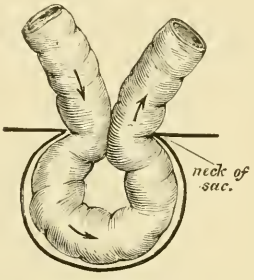
the abdomen may result from the formation of bands associated with an external hernia.

Strangulated Hernia.

A rupture is said to be *strangulated* when, in addition to its solid contents being irreducible, the venous circulation of the parts involved is more or less completely arrested.

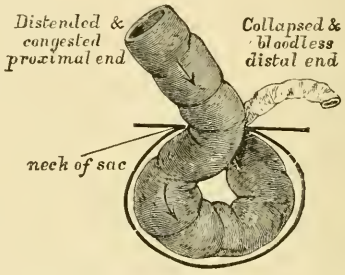
This result may be brought about whenever a knuckle of intestine slips through an opening in the abdominal walls (external hernia) or is constricted from any cause within the abdominal cavity (internal hernia) by air or motion entering the upper extremity of the knuckle, and distending it so as to compress its lower end against the neck of the constricting orifice through which it may have passed (Fig. 306). The greater the pres-

Fig. 305.



An Unstrangulated Hernia.

Fig. 306.



A Strangulated Hernia.

sure from above, under these circumstances, the more the lower end of the bowel will be compressed; consequently, the more complete will be the obstruction, and the sooner the compressed or strangulated bowel will lose its life, the part dying from static gangrene.

Strangulation may happen in the first descent of the rupture—*recent hernia;* but more commonly it takes place after a hernia has existed for many years—*old hernia.* An analysis of cases that I made in 1856 (*Guy's Reports*) indicated that the average duration of an *inguinal* hernia previous to its becoming strangulated was twenty, and of a *femoral* eleven, years. The same analysis likewise showed the most important practical fact that when an inguinal hernia becomes strangulated in its first descent it is generally of the "congenital," and not the "acquired," kind; also that femoral hernia was far more liable than inguinal to strangulation, and to strangulation on its first descent, and that *umbilical* hernia is less liable to strangulation than either of the two other forms, that it is little liable to strangulation in its first descent, and that when strangulated it is almost always of very long standing.

A hernia strangulated on its first descent, whether of the inguinal or femoral form, requires operation more frequently than the "old" hernia and is far more fatal, a strangulated inguinal hernia of the "congenital" kind being by far the most.

The symptoms of strangulated hernia are those of strangulated intestine from whatever causes, and they are due rather to the obstruction of the venous circulation of the strangulated part than to the obstruction of the intestinal contents. In *old inguinal hernia* of many years' standing they may be *chronic;* in *recent hernia*, and more particularly of the femoral or congenital inguinal form, they are *acute*.

It thus often happens that in an acute or "recent" inguinal or femoral hernia its descent is accompanied by severe abdominal pain in the region of the umbilicus, vomiting first of the contents of the stomach, then of those of the duodenum (biliary vomiting), and at a later stage of the yellow contents of the small intestine, and even of feces, and later on by more or less collapse. Constipation is also usually present, although on the first onset of the symptoms it is not uncommon for the large intestines to empty themselves. With these general symptoms of obstruction the local signs of hernia will be present at one or other of the sites at which a hernia may occur; the hernial tumor will be tense and painful and without impulse on the patient coughing.

The general symptoms thus described are common to every form of acute intestinal obstruction, whether outside the abdominal cavity from a hernia, or inside from internal strangulation, ileus, or other cause. In every case in which they occur the practitioner

should carefully examine the site of every possible hernia and not trust to the patient in any way, as the local are often masked by the severity of the general symptoms, and the local cause is thereby overlooked.

The symptoms in an "old hernia" are less acute and are more those of chronic obstruction; they are not, however, less characteristic *when vomiting has set in.* In all probability, before this symptom appears, the patient will have complained of some general abdominal uneasiness, such as flatulence, a feeling of faintness, nausea, and fulness, with local pain in the hernia; the nausea, however, will soon be followed by persistent eructations, hiccough, and vomiting; in most of the cases constipation too will be present, though in some the desire to go to stool will be great and the straining severe. The local signs of strangulation or obstruction are often so slight as to be disregarded by the patient, and unless the hernia is discovered by the surgeon his attention will probably not be drawn to it by the sufferer. Thus, at Christmas, 1870, I reduced a femoral hernia by the taxis strangulated for a hundred hours in a man who was unconscious of its presence till a few hours before.

If the obstruction remain unrelieved, the powers of the patient will probably become prostrate and more or less complete collapse will show itself, with a feeble pulse and cold clammy skin. The vomiting also may diminish in intensity, or even cease, at times remaining only as a passive pouring out through the mouth of the intestinal contents. Pain previously severe may also suddenly disappear. The collapse, indeed, may be so great that the parts about the neck of the sac will become relaxed, and the hernia may go up either by itself or by the gentlest pressure; and such symptoms indicate a serious collapse of the general power of the patient as well as a destruction of the parts strangulated. Under these circumstances death may be looked for, either from the shock to the nervous system, gangrene or death of the strangulated bowel, rupture of the bowel at the line of stricture, fecal extravasation, or peritonitis.

When gangrene of the bowel is the cause of death, the collapse may be as great as it is from shock, although of greater duration. Death, however, is slower.

When rupture of the bowel with fecal extravasation is followed by collapse, it will have been preceded by symptoms of local or general peritonitis or by a sudden severe abdominal pain; for in all cases of strangulated hernia in which any delay in reduction has taken place symptoms of inflammation of the protruded parts, of local peritonitis around the neck of the sac, and subsequently of general peritonitis, will be sure to show themselves.

Strangulated omental hernia is characterized by the same symptoms as the intestinal, though less marked and acute. The pain is not so severe nor the vomiting so constant, constipation is less complete and insuperable, while the constitutional symptoms are also milder. The local distress is likewise inconsiderable, the tumor feeling harder, more nodular, and like to an obstructed hernia, permitting manipulation more freely than when it contains intestine. As time progresses, however, symptoms of inflammation in the hernial tumor will show themselves with those of local peritonitis; and when these appear, they are as severe and destructive as they are in other forms of strangulated hernia. In exceptional cases, however, the omentum may slough.

A strangulated omental hernia requires, consequently, as active surgical treatment as any other, as it leads to the same end—a fatal peritonitis.

Pathological Changes the Result of Strangulation.

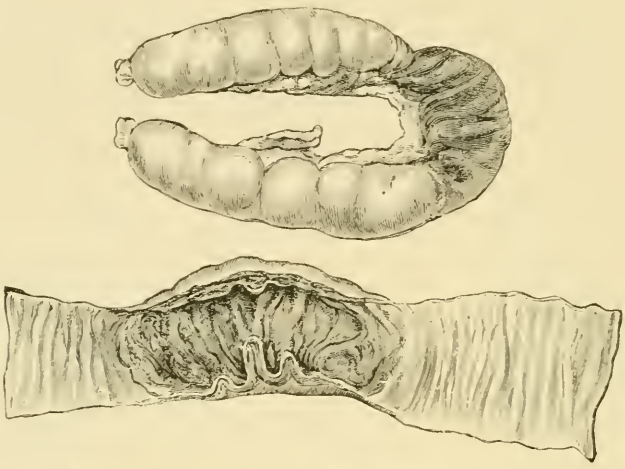
These are the same when they take place within the abdominal cavity as in an external hernia, and under both circumstances the first effect of the *partial* arrest of the venous circulation through the parts is congestion, this congestion being associated with its usual accompaniment, *serous effusion.* When *complete* arrest has taken place, the congestion will be more thorough, the surface of the bowel appearing of a red purple or blackish hue, and the tissues themselves thickened from effusion into their meshes or blackened, wholly or in spots, by extravasated blood (Fig. 307). When they have been much manipulated by the taxis, the extravasation of blood into the tissues is often very marked, the degree of congestion depending upon the completeness of the strangulation.

When the strangulation has been acute or of long standing and an inflammatory action been added to that of congestion, the bowel will be not only swollen, but soft, and the natural glistening aspect and elasticity of its coats will have become changed for a dull appearance and leathery condition. Its serous surface may, indeed, be covered with a layer or with flocculi of lymph, or the knuckle of intestine may be wholly or in part

soft and gangrenous, with ash-colored spots on its surface, and even perforations. When the bowel dies from strangulation, the gangrene will be of the static kind.

At the neck of the sac other changes will also be found, and these depend materially upon the character and seat of the constricting force. Thus, when the line of a strangulation is rigid and linear, as it is in direct inguinal and femoral hernia, the knuckle of

FIG. 307.



Extreme Venous Congestion and Interstitial Hemorrhage the Effects of Severe Strangulation of the Bowel. (Drawing 481°. Birkett.)

strangulated bowel, either as a whole or in part, may be rapidly destroyed by gangrene; and when the pressure is more diffused and less rapid, as in large inguinal hernia, ulceration of the mucous membrane at the line of stricture, even to perforation, is more common, the grooved or sulcated condition of the serous surface in the line of stricture being found in both.

Within the abdomen every indication of peritonitis, from the mere greasy condition of peritoneum to fibrinous, or even suppurative, effusion, may be met with. In most cases local peritonitis will be found about the seat of hernia, and in some the peritonitis will be general. The strangulated portion of bowel will almost always be found at the neck of the sac, if not adherent to it, with more or less matting together of the neighboring coils.

That this peritonitis is to be directly attributed to the strangulation of the intestine is generally acknowledged, few cases of strangulated hernia remaining long unrelieved without local or general peritonitis making its appearance, the peritonitis commencing in the bowel above the seat of strangulation. It is also indisputable that this peritonitis is often aggravated and at times caused by the reduction of the inflamed and injured contents of the hernial sac into the abdominal cavity, but to assert with some surgeons that in the bulk of cases it is the return of the intestine into the abdomen that gives rise to the peritonitis is an assumption which facts hitherto known do not bear out.

When the intestine has sloughed wholly or in part and discharged itself through the wound, an artificial anus is said to exist; and this result is far more common after femoral than inguinal hernia.

When the bowel subsequently ulcerates after its reduction, either at the line of stricture, as it may in inguinal hernia, or at the centre of the knuckle, as is the more common in femoral hernia, extravasation of feces may take place, half of these cases of extravasation being either general into the peritoneal cavity and fatal, or local and at the neck of the sac.

The following facts, published by me in *Guy's Hosp. Rep.*, 1856, on the causes of death in hernia, will tend to prove these points. Out of 17 cases of artificial anus after hernia 13 followed femoral, 3 inguinal, and 1 umbilical. Out of 15 cases of gangrenous bowel 11 were femoral, 4 inguinal. Hence, out of 32 cases of gangrenous bowel, 24 were femoral, 7 inguinal, and 1 umbilical, clearly proving that *gangrene of the intestine and artificial anus are more common after femoral than inguinal hernia.*

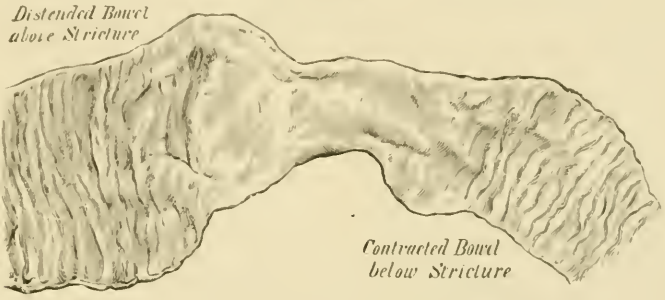
Of 15 cases of hernia in which the strangulated bowel was found perforated 10 were femoral and 5 inguinal; in 4, all inguinal, the perforation was at the line of stricture; in

11 the perforation was in the centre of the knuckle, 10 being femoral. In 8 of these 15 cases extravasation of fæces was prevented by inflammatory exudation sealing the aperture. In 7 it existed, but in 5 only of these was it general; in the other 2 it was local. Of these 7 cases, in 2 the taxis was the direct cause, in 1 gangrene, both being cases of femoral hernia; in 4 ulceration at the line of stricture was the cause, all being inguinal.

From these facts it is evident "that ulceration in the line of stricture with fecal extravasation is more frequent in inguinal than in femoral hernia, and that when it is found in the latter it is generally from rupture of the bowel from forcible taxis."

As a result of a strangulated hernia I must mention a stricture of the intestine due to contraction of the bowel that had been strangulated, a unique example of which took place in my practice in 1870 in a woman æt. 52 upon whom I had operated for strangulated femoral hernia of thirty hours' duration without opening the sac. Convalescence followed the operation, but about the seventh week vomiting appeared, and death took place in the eleventh week, from intestinal obstruction. After death a complete stricture of a knuckle of bowel was found (Fig. 308).

FIG. 308.



Stricture of the Small Intestine after Strangulated Hernia.

The fluid found in the hernial sac varies according to the condition of its contents. In the early period of strangulation, when the venous circulation through the contents of the hernia is only partially arrested, simple serum will be found. When blood stasis is more marked, the serum will be blood-stained. When it is complete and blood has been extravasated into the tissues, blood elements or blood itself will be found in the sac. When the hernial contents are inflamed, flakes or flocculi of lymph will be found floating in the dark fluid. When the bowel is gangrenous, the fluid in the sac will be fetid. When perforation has taken place, fæces, and often gas, will be mixed with the fluid. When the hernial tumor is red, infiltrated, and emphysematous, the surgeon may safely infer that sphacelus of the gut exists.

Thus, the condition of the fluid in and the external aspect of the sac are valuable aids to diagnosis and prognosis in strangulated hernia.

Treatment of Strangulated Hernia.

When a hernia is strangulated, nothing but its immediate reduction should be entertained, since by delay the venous circulation through the strangulated bowel *hourly* increases and the risks of static gangrene are rapidly increased. In the surgeon, indeed, delay is criminal. This may be done by manipulation, or by what is technically called "the taxis," and, when this fails, by "the operation" of herniotomy.

To aid the surgeon in the adoption of these means the use of an anæsthetic cannot be too highly praised, containing as it does within itself all the advantages of every other form of treatment without a single disadvantage. It renders the reduction of a hernia by the taxis a gentle and comparatively simple measure, and certainly a far more successful one than of old. It facilitates, also, the operation of herniotomy on the failure of the taxis. In strangulated hernia the value of an anæsthetic is so great that I would urge, where it can be rendered available, that the taxis should never be employed without it, and that on the reduction of the hernia failing to be accomplished "the operation" ought to be performed. The warm bath, the administration of opium, the local application of ice, are poor and unreliable remedies for strangulated hernia, since they encourage delay, although in *obstructed* or *inflamed* hernia they are of use.

The taxis is not equally successful in every form of external strangulated hernia. In

inguinal cases two-thirds, at least, are reduced by the taxis, a large proportion of these being successfully treated with the patient under the influence of an anæsthetic when the taxis without an anæsthetic had previously failed. Strangulated old are also more successfully treated by the taxis than recent herniæ, and more particularly when the recent cases are of the congenital form.

In *femoral* hernia, on the contrary, the taxis is not half so successful as in inguinal, and it is much more fatal. It is most successful in "recent," whilst in old cases it seldom succeeds.

In *umbilical* hernia two-thirds of the cases are reducible by the taxis.

The Taxis.

With the patient under the influence of an anæsthetic and placed on the back, the shoulders raised, and the legs partially flexed and rotated inward, in order to relax all the parts that can possibly affect the neck of the sac, the surgeon should steadily grasp with the fingers and thumb of one hand the neck of the sac, so as to fix it, and at the same time prevent the contents of the sac, on being pressed, from bulging round the orifice. With the other hand he should then raise the tumor, if large, and gently compress it, so as to empty it of its serous, gaseous, fecal, or venous contents, and thus lessen its size. Having done this, he should draw the tumor first to one side and then to the other, with the view of opening the constricted lower end of the strangulated gut, to allow the contents of the bowel to pass onward. (*Vide* Fig. 306.) He should remember that this *cannot* be effected by any direct pressure upon the hernial tumor itself, but it *may be* by lateral; for if the slightest movement of the lower or constricted end of the knuckle can be made in the direction of the upper or distended one, the lower opening will probably be freed and the reduction of the hernia effected by its *sudden rush* backward into the abdominal cavity, when the surgeon may be assured that all is well.

When the tumor has diminished in size and its diminution has *not* been accompanied by the well-known rushing sensation, a feeling of doubt should ever remain in the mind as to the result, since the want of this symptom of proper reduction should suggest the possibility of a rupture of the bowel, or of a reduction into one or other of the unnatural pouches which are now known to exist under certain circumstances at the neck of an inguinal hernia.

To facilitate reduction a *gentle* kneading movement of the fingers at the neck of the sac may be made in inguinal hernia, as well as a steady traction downward of the tumor, this traction rendering the neck of the sac a straighter channel for the hernial contents to pass through. With a similar object the sac itself may at times be pinched up with the fingers of one hand and drawn downward. Violence in manipulation is unjustifiable under all circumstances, and in proportion to the period of strangulation as indicated by the vomiting, is the danger increased. In femoral hernia also it is comparatively much more injurious than in inguinal, for not only may the bowel be ruptured by forcible taxis—an accident more common in femoral than in inguinal hernia (*Guy's Rep.*, 1856)—but it may be so bruised as to be irreparably injured. A preparation and drawing (Fig. 307) in Guy's Museum show such extravasation of blood into the strangulated bowel of a femoral hernia as to cause its complete death, this being clearly due to a forcible taxis.

Where evidence exists that gangrene of the contents of the sac has taken place, or where, indeed, there is a suspicion of such a result, the taxis must not be used. When the hernia is inflamed or has been much manipulated, the same advice should be followed. In recent or old femoral hernia, where fecal vomiting has existed for some hours, the taxis is a dangerous practice, and in all old cases it is so unsuccessful that reduction by herniotomy is a more certain and safe method. If there be hiccough, the taxis is inadmissible. The taxis may succeed without an anæsthetic, but with it a hernia that is capable of being reduced by the taxis, as a rule, returns on the gentlest manipulation: and when such a result does not follow, force will be not only unsuccessful, but injurious. When the taxis succeeds, vomiting usually disappears, although it may be kept up to a slight extent as an effect of the anæsthetic. The abdominal dragging pain will, however, be at once relieved.

Treatment after Reduction.—After the reduction of the hernia a sponge pad should be carefully adjusted over the neck of the sac, to guard against its re-descent; and when the patient has a cough, the necessity of doing so is increased, as I have known the hernia re-descend and a renewal of all the symptoms take place from a want of attention to this point; indeed, it is wise to adapt a pad till a truss has been obtained. The

patient, under all circumstances, should be kept at rest for a few days after the reduction of a strangulated hernia. The diet, too, should be nutritious, but not solid, *till the bowels have acted spontaneously*, and no aperient under any but exceptional circumstances should be administered, for the bowels will to a certainty act as soon as the effects of their strangulation have passed away and they have recovered their natural tone. If, however, abdominal symptoms appear which can be attributed to a want of the natural action of the bowel, an enema may be given, and repeated with advantage when required. Stimulants should be used with caution. When the bowels have acted naturally, the patient may be pronounced convalescent, and the ordinary diet, etc., allowed.

Where an anæsthetic is not at hand or cannot readily be obtained, a good dose of opium, such as a grain and a half of the solid or thirty drops of the tincture, may be given to an adult and repeated; for when a patient with an old obstructed hernia is brought fully under the influence of this drug, reduction may often be obtained by manipulation. In the very earliest hours of strangulation, before vomiting has become severe or passed beyond stomach vomiting, this practice is also at times successful. It may be tried, moreover, when the surgeon cannot obtain the patient's consent to perform herniotomy and reduction has not been effected by the taxis under an anæsthetic, or when time has necessarily to be lost in making arrangements for operative relief. Under the same circumstances, a *hot bath* (99° F.) may be used. The local application of ice should be employed in cases of *old* hernia where the symptoms are more those of obstruction and delay is a necessity or expedient. In omental hernia also it is particularly valuable, and should be applied over the whole tumor in a loose bag or as a metallic coil. A purgative is never admissible with a strangulated hernia.

The taxis with inversion of the body, the legs flexed, pelvis raised, and shoulders depressed, has been successful in causing the reduction of a hernia, the intestines, by their weight, drawing upon the incarcerated or strangulated bowel and helping reduction. On a bed it may be done by pillows placed below the pelvis; but if one of Alderman's chairs or a lithotomy couch is at hand, it may be used. Some surgeons, with the patient in the recumbent position and a folded sheet placed round the abdomen over the umbilicus, have forcibly drawn the contents of the abdomen upward. Both these methods are founded on the principle of withdrawing by position and force the contents of the sac into the abdominal cavity. They are *possibly* justifiable when herniotomy is not sanctioned nor an anæsthetic employed and delay is dangerous. I cannot recommend them.

The taxis should never be employed for any lengthened period. With the patient under an anæsthetic, femoral hernia of average size (that of a walnut) should never be manipulated for more than two minutes; half that time or less is usually sufficient to effect reduction where it is to be secured, while any more prolonged effort will be injurious. The taxis should never be forcible. In large femoral, inguinal, or umbilical herniæ five minutes may possibly be allowed, but the quarter and half hour's manipulation so frequently talked about is dangerous in the extreme. It is from this fact, coupled with another—viz., that without an anæsthetic twice the force is needed—that the use of such is to be recommended.

The reduction of a hernia by *gentle* taxis with a patient under an anæsthetic is a simple, rapid, and successful operation. The reduction of hernia by *forcible* or prolonged taxis without an anæsthetic is a dangerous and far less successful proceeding. In femoral hernia, indeed, herniotomy had far better be employed. Under an anæsthetic the taxis is almost always successful in inguinal hernia not of the congenital form.

When the taxis has failed, nothing but an immediate operation is justifiable. The operation is not of itself dangerous, although the condition that demands it is exceedingly so. It is not, and should not be, regarded as a last resource, for in many cases it should be the first. When a patient is hanging, the first thing any one does is to cut the rope that is causing strangulation; and no other means are admissible. When a piece of bowel is strangulated, the strangulating medium requires division to give it freedom, the doing of it adding nothing to the danger of the case. The danger lies in the strangulation, which increases every minute.

Herniotomy or Kelotomy

remains now to be described; and let it be repeated *that it is to be performed directly the reduction of a strangulated hernia by the taxis has failed, and, if an anæsthetic is used, while the patient remains under its influence.* To submit a patient to the depressing effects

of an anæsthetic to apply the taxis, and on its failing to allow any period of time to pass before resorting to herniotomy, is a practice to be condemned. It would be better for the patient, and far better practice, to delay the application of the taxis till an anæsthetic can be obtained, and the arrangements for operation made in case the taxis fails.

The objects of the operation are to liberate the strangulated hernial contents, and in a general way to return them into the abdominal cavity, exceptional cases occurring in which it is better practice to leave them in the sac wholly or in part, and others in which it is impossible to reduce them; but to these points attention will be directed farther on.

To liberate the strangulated hernial contents, the cause of the strangulation must be divided; and, as previously shown, this may be found either in the tissues outside the sac, in the neck of the sac itself, or in the contents of the sac.

When the cause of constriction is found outside the sac, as is usual in femoral hernia, the opening of the sac is rarely needed, division outside being all that is required.

When the neck of the sac is the seat of obstruction and prevents reduction, an opening into it sufficient to allow of its division is all that is necessary, as in large old inguinal and umbilical herniæ.

When the difficulty lies in the contents of the sac, the surgeon will be required to lay the whole open and to expose it in order to its removal. But it should be remembered that the less the contents of a hernia are exposed, and consequently manipulated, the better are the results; also, when all that is desired can be secured by the division of the tissues outside the sac, there is no need of doing more; and that when the division of the neck of the sac allows of the reduction of the hernia, a greater exposure of the contents of the sac is unnecessary and wrong, for in hernia, as in all surgical interference, the surgeon should carry out his objects in the simplest way his art can allow, and should never allow himself to do more than the absolute necessities of the case demand. Meddlesome surgery is always bad, but in hernia it is too often fatal.

These remarks, however, are only entirely applicable to cases of strangulated hernia in which the whole contents of the sac are reducible, since, when *some portion remains behind*, a feeling of doubt may at times remain as to the thoroughness of the reduction of the strangulated portion or the condition of what is left, and under these circumstances it is usually advisable that the sac be opened and explored: yet it is better to do so after the partial reduction of the hernia, when, in all probability, the strangulated bowel has been reduced, and is consequently out of harm's way, than with the whole contents of the sac *in sitû* and when they may be exposed. When the *hernia cannot be reduced without opening the sac*, the whole must necessarily be explored. It will thus be seen that the question of opening or not opening the sac resolves itself into the necessities of the individual case. When reduction can be effected without it, the "minor" operation is sufficient; where reduction cannot be effected by the "minor" the major" operation must be performed.

The surgeon who opens the sac in *every* case clearly often does what is unnecessary. He who opens it only when reduction cannot be effected without so doing, or when any uncertainty exists as to the condition of the parts contained in the sac, is free from such an error; "and although we dare not venture to say that some of the fatal cases which have occurred after opening the sac might have terminated differently had it not been incised, we do not hesitate to affirm that the untoward circumstances stated as likely to happen when the sac is not opened have not occurred" (Birkett). This view is supported by my analysis of 126 fatal cases of hernia (*Guy's Rep.*, 1856)—in which I proved fairly that in no single fatal case could the opening of the sac have had the slightest influence in retarding or preventing the fatal result—as well as by my own personal experience. The surgeon who advocates the major operation in most cases will try the taxis, and, I take it, is always well pleased to effect the reduction of a hernia by such means. The operation of herniotomy "external to the hernial sac" differs only from the taxis in the skin wound; yet in what way the necessity for that wound renders the taxis an unsafe measure it is difficult to conceive. It would be as reasonable to reject the administration of an anæsthetic for the renewed application of the taxis in cases where the taxis had failed to reduce the hernia without its aid as to say that because the taxis had failed and a cutting operation is demanded, the ocular inspection and manipulation of the strangulated, and therefore already injured, bowel is required. To argue that the liberation of a strangulated bowel is not complete until it has been carefully examined, and that, moreover, without opening the sac, a hernia that is strangulated by omental or other adhesions or by the neck of the sac may be reduced, is to raise objections which, if

applicable at all, are as forcible against the taxis as any operation, and are, indeed, of little weight.

The operation of herniotomy without opening the sac has been ably advocated by Petit, who first adopted it in 1718, by Munro, in 1770, Aston Key, in 1833, Luke, and others.

So far as statistics are of value toward the solution of this matter, they are in favor of *not* opening the sac. Thus, out of 59 cases of strangulated femoral hernia operated upon at Guy's Hospital in eight years in which the sac was *opened*, the mortality was 50 per cent., and out of 45 cases in which the sac was *not opened*, it was only 20 per cent., the difference between the two classes of cases being 20 per cent. in favor of the minor operation.

Out of 35 cases of inguinal hernia in which the sac *was opened*, 60 per cent. died, and out of 9 in which the sac was not opened, 2, or only 22 per cent. died, the difference between the two classes in inguinal hernia being 40 per cent. in favor of *not opening*. But it must be remembered that as a rule the cases in which the sac was *not* opened were of a more favorable kind than those in which it *was*.

In umbilical hernia it is a rare thing, however, to save a patient after opening the sac and exposing its contents, though when this is not done a good result may be looked for.

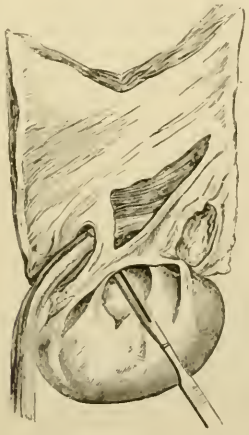
Whenever **the taxis is applicable** to a strangulated hernia and fails, herniotomy without opening the sac is applicable, and where reduction is effected nothing more is needed. Where reduction cannot be effected or a doubtful something remains in the sac, where the contents of the sac have not gone back with their normal rush or the symptoms persist and any doubt about the condition of the parts at the neck of the sac is raised, an exploration of the sac and its neck is absolutely necessary.

Whenever **the taxis is inapplicable**—that is, when the strangulation has been of long duration, the symptoms severe, fecal vomiting persistent, and the local as well as general symptoms indicate the probability that the strangulated gut has died or is dying; whenever, moreover, during the application of the taxis, by the sudden collapse or yield of the tumor without its reduction, the fear is excited of some rupture of the bowel having taken place,—herniotomy by the minor operation is inapplicable, and the sac must be laid open.

Operation.—The patient, having been brought under the influence of an anæsthetic, should be placed with the shoulders slightly raised, the knees flexed upon a pillow, the integument over the seat of hernia shaved of all hair and well washed; an incisson should then be made over the neck of the sac—that is, in inguinal hernia, along the line of the inguinal canal, from the internal to below the external ring; in femoral, over or on the inner side of the crural ring, either in a vertical direction or in the course of Poupart's

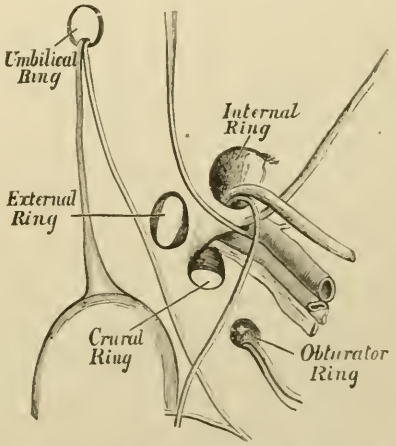
Fig. 309.

A



Key's Director passed beneath the Seat of Stricture of a Strangulated Femoral Hernia outside the Sac beneath the Fascia Propria. (Taken from his work on *Hernia*.)

B



Drawing to illustrate the Relative Position of all the Abdominal Rings from within.

ligament, the former being preferable. In this incision all the soft parts should be cut through consecutively down to the sac, each layer of tissue being divided the full extent of the wound, while all vessels, as they bleed, should be twisted.

When the sac has been exposed, the seat of stricture outside its neck must be felt for with the index finger; and when felt, a director may be carefully passed beneath it, Aston Key's flat director, shown in Fig. 309, A, being by far the best.

With a straight or curved hernia knife, such as that figured (Fig. 310), or with a herniotome (Fig. 310, B), the stricture should then be divided, the incision *upward* being the safest. This division must not be too free, a quarter of an inch being generally ample in a small hernia. It should, under all circumstances, be only enough to allow of the return of the hernia without force. It is better to have to extend it than to make it too large at first. The stricture having been divided outside the sac, reduction by the gentlest manipulation can then be attempted; and when the contents of the sac go back with a rush, all the surgeon needs has been effected. When no indications of reduction show themselves or a portion of the contents of the sac has disappeared, but not with the characteristic jerk, or some piece has been left behind, the sac must be opened. To open the sac care is needed, the danger of carelessness consisting in wounding the bowel. To avoid injury to the contents the sac may be nipped between the thumb and finger or seized with forceps, and, being slightly raised, opened with a scalpel applied laterally. Through this opening a director should be passed, its point being kept close to the inner surface of the sac toward its neck, and upon it the sac should be divided with a bistoury. The escape of fluid usually indicates the opening of the sac, and the character of the fluid the condition of its contents. But fluid does not always run away when the sac is opened, and at other times the escape of fluid from a cyst on the hernial tumor may mislead. The sac having been opened, its contents should be examined; and in doing this the utmost gentleness must be employed. When a *knuckle of intestine* is present and is neither gangrenous nor perforated, the abdominal cavity is the best place. It may be black from congestion and spotted from ecchymosis; it may be granular from lymph, or even covered with false membrane; but as long as it possesses its living resiliency, is not fetid, flaccid like wet wash-leather, ruptured, or perforated, it should be returned.

FIG. 310.

Hernia Knife.

Herniotome Director. A, Blade withdrawn. B, Blade exposed.

When a *large quantity of injured intestine* is found in the sac, it had better be left, the surgeon simply relieving the constriction by the division of the stricture. To do this a director should be employed, and its point kept close to the inner surface of the sac and away from the bowel; it should not be introduced farther into the abdominal cavity than is required to ensure the safe division of the stricture; when the knife is passed along the groove of the director, the finger of the operator should carefully press the strangulated bowel away to protect it from injury. The finger, however, is the best director, and should be introduced to the neck of the sac, with the knife upon it, having its side pressed into the pulp of the soft parts. Both having thus reached the neck, the knife may be carefully turned upward and the tissues divided, the point of the finger measuring the extent of the incision.

When a herniotome such as that figured (Fig. 310, B) is used, no director need be employed.

When the *intestines are adherent* to the sac or to one another by filamentous or soft adhesions, these may be divided; such are, however, only met with in recent hernia. The fibrous adhesions of old herniæ had better be left alone and the hernia considered as irreducible, the surgeon being satisfied, under these circumstances, with dividing the stricture and thereby relieving the strangulation, but not attempting the reduction of the hernia. If a fresh piece of bowel comes down, it should be reduced; but the old hernia ought to be left.

The strangulated intestine, under all circumstances, should be handled with extreme delicacy. *Any drawing down of the bowel* to examine its condition should be avoided, since such an act can do no good, but often does much harm in tearing away adhesions that would have sealed an ulcerated orifice, prevented extravasation, and assisted repair. *Any introduction of the finger* into the abdominal cavity save under exceptional conditions is also to be condemned. With the careful return of the bowel within the neck of the

sac surgical interference ought to cease. The surgeon may satisfy himself that such an end has been attained without probing the abdominal cavity with his finger, and thus risking life by tearing away adhesions and undoing in a moment what nature by her own processes had probably been attempting from the first period of strangulation—namely, to shut out from the general abdominal cavity what might prove injurious and dangerous to life.

When the *bowel is dead*, as indicated by its flaccidity and ashy color, all thought of its reduction must be abandoned. The soft parts covering in the sac, with the sac itself, should be freely laid open, so as to expose the whole sloughing mass, *and the intestine left to nature*, to pass into what is called an "artificial anus." The neck of the sac may be carefully divided—not, however, with the view of relieving the strangulation, for the gut, having become gangrenous, is no longer strangulated, but with a view of allowing the intestinal contents to escape when an external opening takes place, and should life be spared, and likewise for the subsequent retraction of the bowel toward the abdominal cavity, to effect a natural cure.

No free incision into the gangrenous bowel, no stitching of the intestine to the margin of the wound, is required, as fæces will soon find their way through the opening that has been made by the artificial anus, and the surgeon may be certain that within the abdomen sufficient repair has gone on to fix the intestine that had been strangulated to the neck of the sac and thus prevent its immediate retraction; for it must be remembered that as time goes on this retracting process is precisely that which nature adopts to procure a spontaneous cure of an artificial anus.

Within recent times a gangrenous knuckle of bowel has been *resected* (*vide Revue de Chirurgie*, May 10, 1883), and with success. When this operation is performed, the bowel above and below the constricted portion will have to be drawn down, resected, and stitched together as illustrated in Fig. 283, or the two ends of the resected bowel may be retained at the neck of the sac by sutures or forceps.

When the *bowel is perforated by ulceration or ruptured*, and the opening is not large, the neck of the sac must be incised, as in an ordinary case, and the intestine that appears reparable replaced, the perforated or ruptured portion being left at the mouth of the sac. When the rupture or perforation is small, there is no objection to the surgeon suturing the wound and replacing the gut within the orifice of the sac, for plastic lymph will probably be poured out within a few hours and the parts become sealed from the abdominal cavity.

When *the bowel is in a doubtful condition*, and the surgeon is not certain whether he can say it is irreparably dead or going to die, the abdominal cavity is still its best place, when it can be returned. Aston Key advocated this plan many years ago, and modern experience has not disproved its value. "The danger of abdominal extravasation will not be increased by replacing the injured bowel within the neck of the sac; for should sloughing of its coats ensue, the slough may be walled in by addition of the surrounding peritoneum, and fecal extravasation be prevented" (Key, *Guy's Rep.*, 1842).

In an inquiry in 1856 into the causes of death in hernia, founded on an analysis of 156 fatal cases, the same conclusion was arrived at. The weight of evidence led me then to express the opinion that there is only one condition of intestine in which its reduction within the neck of the sac is not advantageous, and that is when it is decidedly ruptured by gangrene or ulceration, my own materials tending to support the opinion of Mr. Aston Key, as stated to the writer in 1849, "that in all conditions of the intestines the abdomen was their right place."

Mr. Hutchinson, who believes peritonitis to be the direct result of the reduction of an injured bowel into the abdominal cavity, advises in all cases that the damaged gut, if found in a bad condition, should be left in the sac; while Mons. Girard goes further, advising the contents of the hernia, under all circumstances, to be left, the surgeon contenting himself by freely dividing the stricture. I cannot concur in this practice, nor with the principle on which it is based.

When the contents cannot be returned, on account of adhesions, the neck of the sac should be incised and the case left to nature. In large umbilical herniæ, also, this practice is valuable.

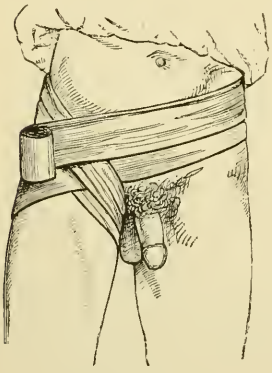
When omentum is found in the sac with intestine and has only *recently* descended, it may be returned. When it has been down for some time, is irreducible, and is only a small piece, it should be left alone, the omentum, doubtless, often acting as a plug to the orifice of the sac. When it is diseased or in large quantities, it should be ligatured in two or more portions and cut off, the ligatures being applied as near to the neck of the sac as possible, care being observed not to disturb the parts at the neck.

Simply to cut off the omentum and to tie or twist the vessels is risky, the omentum always being highly vascular and small vessels being apt to bleed much; indeed, cases are on record in which a fatal hemorrhage supervened after this practice. When diseased omentum is left in the sac, prolonged suppuration often follows. Whenever intestine and omentum are found together in a hernia, much care is required. The intestine is generally to be sought for *behind* the omentum, but is often wrapped up in it, and in not a few cases covered by an omental sac. Under all these circumstances, the intestine should be exposed and carefully reduced, care being taken that no adhesions at the neck of the sac or no bands bind the bowel down to the omentum, thereby keeping up the strangulation. An omental sac is on no account to be returned into the abdomen unopened. Omental sacs are generally found in femoral hernia. An interesting paper by Prescott Hewett (*Med.-Chir. Trans.*, 1844) may be referred to on this subject.

It has been my practice, and that of most of the surgeons at Guy's Hospital during the last three or four years, to dissect out the sac after the operation, stitch up its neck, and excise its fundus, this measure apparently but little, if at all, magnifying the operation, and being successful as a radical cure.

After-Treatment.—When a hernia has been returned into the abdominal cavity, the more the case is left to nature, the better. As a matter of precaution after the operation, as after its reduction by the taxis, when the wound has been brought together with strapping or suture, a pad may be adjusted over the part with a spica bandage (Fig. 311). A sponge is the best form of a pad.

Fig. 311.



Spica Bandage.

A suppository of half a grain of morphia or more should be at once introduced into the rectum, and repeated in an hour should pain render it necessary; a little ice, too, may be allowed for the patient to suck when thirst is great; but the less that is taken by the mouth, the better. When the powers are very feeble, brandy, soda-water, and ice may be given in small quantities.

If no anæsthetic sickness complicate the case after the first twelve hours, beef tea, arrowroot, or milk may be given, a pint or a pint and a half in the twenty-four hours being ample. Stimulants should be allowed as the powers of the patient indicate, but always with caution.

On the second day the wound should be dressed, some simple dressing being all that is usually required, the lower end of the wound being left open for the escape of fluid. Should pain continue and symptoms of peritonitis appear, opium should be given, or morphia suppositories twice a day or more frequently; indeed, the patient should be kept under the gentle influence of opium till the symptoms are relieved; hot fomentations should also be applied to the abdomen. Purgatives ought never to be given if the bowel has been bruised or otherwise injured by strangulation, for as soon as it has recovered its tone its natural action will return, and any goading of it to action by medicine must do harm. "A bruised bowel," says Aston Key (*Guy's Rep.*, 1842), "is placed by nature in a state of rest; the exhaustion of the nervous energy of the part diminishes in the muscular tissue the disposition to contract. *Such inactivity of the bowel should be encouraged, and not thwarted* by irritating purgatives. The surgeon's anxiety to procure stools should yield to the evident necessity for time being allowed for the restoration of the natural powers of the injured bowel.

Three, five, ten, or even twenty, days may be allowed to pass without any action of the bowels without anxiety or without purgatives, so long as no other indications of mischief show themselves; but during this time only liquid food is to be given, with stimulants as may be required. When some local distress is present which the surgeon can fairly attribute to the constipation, an enema of gruel and olive oil may be administered, which may be repeated if necessary, such a simple intestinal stimulant being usually sufficient to induce the bowel to act should it have recovered its tone. When the bowels have acted naturally, convalescence may be declared and the usual diet allowed.

Any violent action of the bowels soon after the operation must be regarded with anxiety, and in the aged it is too often followed by a fatal collapse. When too frequent, it must be checked by opium. The patient should on no account be allowed to get up and walk until he has been fitted with a good truss.

It occasionally happens that after the reduction of a hernia by operation the symp-

toms of strangulation persist and the surgeon is in doubt as to their cause. Moreover, the bowel may not have gone up at the time of the operation with the usual rush, or the surgeon may have a doubt in his mind as to its right reduction. Under these circumstances, the wound may at times require reopening and the parts at the neck of the sac re-explored, since the case may be one of those "displaced herniæ" to which attention is now to be drawn.

As a rule, however, the persistency of the symptoms is due to the obstruction caused by the injured bowel or to the anæsthetic.

Multiple Herniæ.

When *two or more herniæ* exist with symptoms of strangulation, the one that on careful examination appears to be the most tender ought first to be explored, and should this operation not give relief the second should be treated in a like manner; indeed, if no relief be given by the second operation and a third hernia exist, it should also be explored, for it cannot be too often repeated that the operation is not one of danger when compared with the necessity of the case that demands it. Dupuytren in his *Leçons Orales* has recorded such a case. In the third part of my *Clinical Surgery*, p. 204, I have likewise recorded another in which Mr. Cock was the operator. The patient was a man æt. 70; the left side was first explored, but, as the symptoms continued, the right was operated upon twelve hours later. Both herniæ were old inguinal; in both the sac was opened, and recovery took place. In the case of a Jewess æt. 30 I was called upon to see, with an umbilical and double femoral herniæ, I operated on the right femoral for strangulation, and a year later upon the umbilical, with success.

Displaced Herniæ.

No cases demand closer attention than these. When understood and appreciated, they may be successfully treated; when misunderstood, they are sure to be overlooked. Hence it may be accepted as a fact that a strangulated hernia with its sac may be bodily reduced within the abdominal ring and behind the abdominal parietes, the intestine being still held by the neck of the sac (Fig. 300). This form was first described by the French writers as *reduction en bloc* or *en masse*, and by Mr. Luke in this country (*Med.-Chir. Trans.*, 1843). The majority of cases reputed to be of this nature are, however, probably caused by other lesions of the sac, and the credit of having made this out is due to Mr. Birkett, in an able paper read before the Royal Med. and Chir. Society in 1859. He describes three forms, though his observations apply only to inguinal hernia.

There are four varieties of displaced hernia, and in the inguinal they are mostly found as complications of the congenital form.

First Form.—In this the strangulated hernia with its sac may be bodily reduced within the abdominal ring and behind the abdominal parietes; it is to a femoral hernia that this accident is most prone to occur, but it may do so to an inguinal. It is the true *reduction en bloc* or *en masse* of the French writers and of Luke. Such cases are, however, rare. In November, 1871, I had this fact demonstrated to me in a case I was called to see by Mr. Berry of Pentonville. It was in a lady æt. 64 who was said to have been ruptured for years, and had worn a truss. When I saw her, she had been vomiting for a week and a tense femoral hernia existed. Under chloroform I cut down upon the sac and divided the neck of the crural ring, and, on attempting reduction of the sac's contents by gentle manipulation, to my surprise the sac with its contents suddenly disappeared into the abdomen. By a little abdominal pressure it was made to reappear, and it did so in the same sudden way. A second attempt at the taxis was followed by the same result, and renewed pressure upon the abdomen with a like reappearance. For the sake of fully satisfying myself and my medical friends of the nature of the case, I reduced the hernia *en masse* a third time, and then found some little difficulty in securing its reappearance. When I did so, I took hold of the sac with my forceps, carefully opened it, and exposed the bowel without letting the sac go: I then divided its neck by a herniotome and reduced the bowel, keeping the sac well down. On the second day the bowels acted, but the patient subsequently died of a low form of peritonitis. In this case the whole process of reduction *en masse* was demonstrated most clearly, and it compelled me to ask the question whether the same result might not have taken place had I attempted its reduction by forcible taxis without operation, since the facility with which the sac passed up within the crural ring was something startling.

In Prep. 2503[30], Guy's Hosp. Museum, this accident may be seen. It was taken from a woman æt. 58, and my friend Mr. Henry Morris showed a specimen illustrating this fact at the Pathological Society. (See *Trans.* for 1871.)

Second, or Charles Bell's, Form.—In the *second* form the neck of the sac becomes detached by force from the internal abdominal ring and pushed upward beneath the abdominal walls, the intestine within the sac being strangulated by the orifice of the sac. This variety is illustrated by Fig. 297, and still better in Figs. 312 and 313, which I have copied from page 486 of the first volume of the *Medical Gazette*, published in 1828. The case formed the subject of a lecture by Sir Charles (then Mr.) Bell. It occurred in a man æt. 47 who had been the subject of a right scrotal hernia for twenty years. The hernia had come down and become strangulated three days before he was seen, but had been reduced, or rather *made to disappear*. The symptoms, however, continued, and death followed. During the last twenty-four hours of the patient's life the hernia came down repeatedly during the day, and was each time reduced with great facility.

After death the hernia was found to be in the scrotum, strangulated and mortified (Fig. 312). On applying pressure to it "the intestine could very easily and effectually be pushed through the external abdominal ring, so as to be hid from sight. On looking to the inside, however, it was seen that the portion of gut had carried the neck of the sac before it into the abdominal cavity (B, Fig. 312), and the duplicature of peritoneum which hung upon the inside of the neck of the sac, being unfolded, had formed a new sac for the intestine in the inside of the abdominal muscles. Thus, the fold of intestine was pushed through the external ring, through the spermatic canal, and through that part which is described to be an internal ring (but of which no trace could be seen), and was reduced within the abdominal muscles, but not within the abdominal cavity," the neck of the sac still grasping the included portion of gut (B, Fig. 313). The hernia was also clearly of the congenital form, although it had not descended as far as the testicle.

The two drawings (Figs. 312 and 313) and descriptions are as originally given by Sir C. Bell.

Fig. 312.

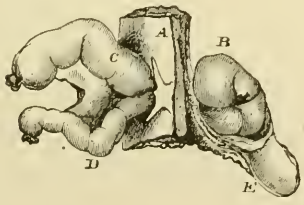
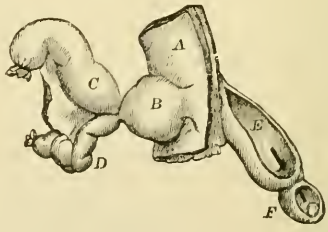


Fig. 313.



Drawings illustrating the Second Varieties of Displaced Hernia.

Fig. 312.

A, A portion of the abdominal muscles, with the peritoneal lining.
B, The strangulated fold of intestine.
E, The testicle. The dark lines at the neck of the sac represent the duplicature of the peritoneum, which, being unfolded, formed a sac for containing the intestine when reduced

Fig. 313.

A, Peritoneum lining the abdominal parietes.
B, The tumor formed when the strangulated intestine was pushed through the spermatic canal into the sac formed by peritoneum in the inside.
C, The superior portion of intestine.
D, The inferior.
E, The scrotal hernial sac.
F, The testicle, with the vaginal coat opened.

This case I have described somewhat fully, as I believe it to be the earliest on record in which this accident has been clearly made out.

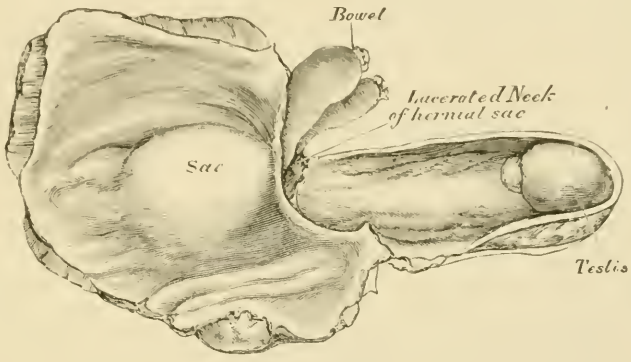
Third Form.—In this (Figs. 298 and 314), "as the effect of forcible and long-sustained compression of the hernial tumor, the delicate serous membrane of the sac is rent, burst, or torn, and the hernia makes its escape through the aperture into the subserous connective tissue; its course outside the peritoneal sac is advanced by continued pressure, and, detaching the connections of the neighboring peritoneum, it forms for itself a pouch between that serous membrane and the internal abdominal fascia" (Birkett). The posterior part of the neck of an inguinal hernial sac is the usual seat of the rupture, and the position of the artificial sac is downward and outward. The "congenital" form of hernial sac is also the more liable to the accident. (*Vide* Fig. 314.)

The indications of the accident having taken place are as follows (I give them in

Birkett's words): "The tumor becomes flaccid, and therefore smaller, the bulk of the tumor slowly diminishes as the pressure is continued, until at last very little, if anything, can be felt, but the *surgeon has failed to experience that sudden jerk so characteristic of the escape of the hernia* from the gripe of the mouth of the sac as it enters the abdominal cavity. After the effects of the chloroform have passed away *all the symptoms of strangulated bowel recur*, and perhaps with increased force. Even the tumor itself may reappear and recede on the application of slight pressure."

When this condition is found, there is but one form of practice to follow, and that is the exploration of the sac. At its neck two orifices will be found, one dipping down into the artificial sac and the second into the abdominal cavity; from the latter the bowel will be seen to pass through the former into the artificial sac. The surgeon must then draw out the bowel from the sac through its false orifice, and, having freely divided the true neck or abdominal orifice of the sac, replace the intestine; and "the exercise of great care and caution is needed to prevent the entrance of the hernia once more into the abnormal space outside the peritoneal cavity" (Birkett).

FIG. 314.



Third Variety.
Interstitial Hernia, with ruptured neck of hernial sac.

Fourth Form.—In this an intermuscular, interstitial, or *intra-parietal* sac has also been described, being a kind of diverticulum from the inguinal sac, and is almost always found, according to Birkett, associated with the congenital form of hernia. The sac may be found in the anterior abdominal walls in an upward, outward, or inward direction, mostly behind the abdominal muscles in front of the abdominal fascia, though in some instances in front of the external oblique muscle beneath the skin. Birkett refers to a case recorded by Scarpa, and to a second by Dr. Fano.

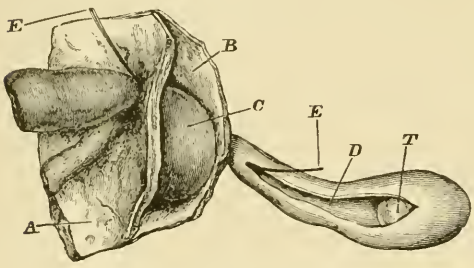
I saw an example of this in 1883 in a patient of Dr. Kershaw of Surbiton. The patient was over sixty and had been ruptured for years. A day or so before I saw him, in attempting reduction, the hernia partially left the scrotum, and a swelling appeared above the groin and steadily increased till it reached nearly to the umbilicus. The swelling, when I saw it, was nearly the size of a cocoanut, soft, and resonant. It was clearly bowel, and not strangulated. Ice was applied, and in the course of time it returned into the scrotal sac and gave rise to no inconvenience.

In some cases the sac extends to the iliac fossa and rests upon the iliacus muscle, between the internal abdominal fascia and peritoneum, or, directing itself inward, it passes behind the horizontal ramus of the pubes and reaches the side and front of the urinary bladder (Birkett). Fig. 299 illustrates this form of hernia, but Fig. 315 does so much more clearly. It was taken from a preparation now in Guy's Museum, which was removed from a man æt. 36 upon whom I operated on September 23, 1869, for strangulated hernia. The man had been ruptured for fifteen years and had worn a truss. The hernia had descended two days before his admission into Guy's, but the man had pushed it up by manipulation after a little trouble, though it did not go up, as usual, with a rush. After its reduction vomiting appeared and local pain, and in this condition he was admitted into the hospital.

When I saw him, all the symptoms of strangulation were present. No hernia was down, but there was some fulness at the internal ring, and above this, toward the crest of the ilium, a tense globular swelling could be felt. This swelling I explored, and, having laid open the inguinal canal, I exposed the empty hernial sac (D, Fig. 315), with

the testicle, showing that the hernia was of the congenital form. I then passed my finger into the internal ring, and came against a knuckle of tense distended intestine. I enlarged the opening, and this intestine, which was of a dark color, but still glistening, at once protruded. In following this up my finger passed downward and outward into a distinct cavity, which was not the abdominal cavity (C, Fig. 315), filled with bowel. It was a distinct sac with a smooth surface and about the size of an egg. At its upper surface it communicated with the hernial sac, and above this with the abdominal cavity. I then increased the orifice leading into the abdominal cavity, drew out the strangulated bowel from the intra-parietal sac (C, Fig. 315), and returned it into the abdomen. The sac was clearly placed below the internal ring and between the abdominal muscles and peritoneum. The man died from peritonitis on the fourth day, his death allowing me to take the very excellent preparation from which Fig. 315 has been taken. The case was clearly one belonging to Mr. Birkett's third or my fourth form, an intra-parietal sac (Fig. 315, C) existing below the internal ring.

Fig. 315.



Drawing illustrating the Fourth Variety or Intra-Parietal Form of Displaced Hernia.
A, Peritoneum lining the abdominal muscles (B).
C, Intra-parietal sac with strangulated bowel.
D, Scrotal hernial sac leading down to testicle (T).
E, Director passed from the congenital scrotal sac through the internal ring.
In the drawing the strangulated bowel has been introduced to make the description clearer.

The disappearance of the tumor without the characteristic jerk and the persistence of the symptoms indicate all these forms. The treatment in all is the same as that described in the *third* variety.

Prognosis.—As the danger of a strangulated hernia depends upon the amount of damage the intestine has sustained by the strangulation, so the amount of damage the bowel has received is to be measured by the intensity of the strangulation and its duration. A tight, unyielding strangulation such as usually exists in a recent femoral or in a congenital or direct inguinal hernia does more harm in a short period than a less tight and more yielding constricting force, such as is met with in an old oblique inguinal hernia, in a longer period, violent taxis adding materially to the danger of the case.

The existence of peritonitis before the reduction of the hernia is always an unfavorable sign, as it is not likely to be lessened by the introduction into the peritoneal cavity of a portion of bowel already inflamed and altered in character. A hernia in an otherwise healthy subject, that has not been strangulated for many hours, that has not been injured by violent manipulation, and has been reduced by the "minor" operation, will probably do well, whereas one that has been strangulated for days or been subjected to violent taxis will probably do badly.

Where disease of the kidneys or of other viscera exists and in old people, the prognosis is always unfavorable.

A case in which the intestine has been freely exposed is more unfavorable than one in which no exposure has taken place, and any excessive manipulation of the hernial contents always adds to the danger.

The reduction of a severely damaged intestine is more liable to be followed by a bad result than where little injury exists, but a bowel only slightly injured in an aged or unhealthy subject is always likely to do badly.

A hernia strangulated in its first descent requiring operation is always far more fatal than an "old case."

In private practice, where herniæ, as a rule, are discovered and treated early, good success follows herniotomy; but in hospital practice, where neglect and delay combined have had their influence, treatment is very unsuccessful, nearly one-half the cases dying. At Guy's Hospital the average period of strangulation for femoral hernia is seventy-six hours; of inguinal, fifty; and half the cases that die after the operation do so within forty-eight hours, the injury to the bowel being so great and the power of the patient so reduced that any reaction after the reduction of the hernia is rendered impossible. Under these circumstances, the worst that can be said for the operation is that it fails to cure.

Inguinal Hernia.

Inguinal hernia, or that form which protrudes through the internal or external abdominal rings, includes two-thirds of all cases of hernia and about half of all cases of strangulated hernia. Two out of three cases of strangulated inguinal hernia are reducible by the taxis, the third requiring operation. In hospital practice half of those operated upon die, operations in recent cases being most fatal.

An inguinal hernia is called *oblique* when it passes through the internal ring and along the inguinal canal downward toward the scrotum; *direct*, when it does not pass through the internal ring, but through the external in a direct way.

The oblique, from being anatomically placed external to the deep epigastric artery, is called *external oblique*, while the direct, from being internal to the same vessel, is known as the *internal direct*.

When the oblique has not passed the external ring, it is known as a *bubonocele;* when the oblique or direct has passed into the scrotum, it is called a *scrotal hernia* or *oschcocele*.

In the *oblique inguinal* the sac of the hernia may be the natural "vaginal process of peritoneum" that was formed on the descent of the testicle in fœtal life and has not closed —*i. e., a congenital sac* (Figs. 292, 293, 294)—or an *acquired sac* formed by the gradual pouching of the parietal peritoneum through the ring (Fig. 296).

In the *direct inguinal* the sac is always of the acquired form.

This "vaginal tubular process of peritoneum" which communicates above at the internal abdominal ring with the peritoneal cavity, and below is in close contact with and adherent to the testicle, lies in front of the spermatic cord, and before birth, or soon after, "it contracts near the head of the epididymis, its surfaces adhere firmly at that spot, and thus two cavities are formed." The inferior one forms the permanent covering to the testis, and is known as the tunica vaginalis propria testis. The superior canal, when no arrest of development takes place, subsequently contracts till the canal ceases to exist.

When an arrest of development occurs and the abdominal orifice of the tubular process remains patent, a piece of intestine may at any time descend. *When the whole length* of the canal is open, the hernia will pass down at once into the scrotum to the testicle, masking its presence; and in this way the *congenital hernia* of Haller, the *hernia of infancy* of Malgaigne, or the *hernia into the vaginal process of peritoneum* of Birkett, is formed (Fig. 292).

When the closure of the canal takes place higher up—and such an event is possible at any point from the testicle upward—the descent of the hernia will be limited, though its nature is the same, the only difference being that in this condition the testicle will be found below the hernial sac at a variable distance and separated from it. To this form of rupture Birkett has given the name of *hernia into the funicular portion of the vaginal process of the peritoneum* (Fig. 293 or Fig. 313).

It should also be mentioned that it is not uncommon for this tubular vaginal process to close at its abdominal orifice at the internal ring and yet remain more or less open as a cavity below, and under these circumstances any *sudden rupture or giving way* of the closing medium will be followed by the rapid formation of a hernia, the hernia being scrotal wholly or in part, lying upon or separated from the testicle, according to the absence or position of any point of closure. This form of hernia differs only in the sudden giving way of the abdominal orifice of the vaginal process from those last described, and is very common in young adults.

For all those forms of hernia in which the sac is composed of the natural tubular vaginal process of peritoneum the term *congenital form* of hernia would probably be the best, as indicating their nature, distinguishing them from the other form, rightly called the *acquired*.

This congenital form of hernia is also frequently associated with some malposition of the testicle, such as its non-descent or partial descent.

The *infantile hernia* of Hey or the *encysted hernia of the tunica vaginalis* of Sir A. Cooper is an acquired hernia, the hernia *gradually pushing* the tissues closing the orifice of the vaginal process of peritoneum downward into the open canal, the protruded parts, together with the sac, being contained in the tunica vaginalis testis, and the true sac being within that which might have been the congenital (Fig. 295).

The hour-glass contraction of a scrotal hernia is always found in the "congenital form," and is due, as described by Birkett, to the imperfect closure of the vaginal sheath above the testicles, where union of its walls normally takes place. Prep. 2368 in Guy's Museum will explain these cases, also Fig. 294.

The acquired form of inguinal hernia, oblique and direct, is *always slow* in its formation, the pushing downward of the parietal layer of peritoneum by the protruding viscera being a gradual process, thus forming a marked contrast with the congenital form. In the oblique it begins as a slight yielding at the internal ring, and in the direct at the external, this yielding passing into a "pouching," till at last the pouch may reach, and even fill, the scrotum. In the early stage this yielding may be scarcely perceptible, but the patient it will give rise to a feeling of weakness, and often of pain, on any abdominal muscular exertion being made. When a "pouching"—or, according to Malgaigne, a "pointing"—of the hernia has commenced, any act of coughing or straining will make it visible.

When the *oblique* hernia has filled the inguinal canal, it will appear as an ovoid swelling *above* Poupart's ligament (*vide* Fig. 301) beneath the tendon of the external oblique muscle. When it has passed through the external ring, the long axis of the tumor, and more particularly its neck, will still be in the inguinal canal above and parallel with Poupart's ligament; but, having escaped from beneath the external oblique muscle, it will appear as a pyriform scrotal tumor of variable size. The testicle will always be found below and distinct from the sac, the cord being behind the tumor.

In the *direct* inguinal form in which the pouching of the hernial sac is directly behind the external ring (Fig. 302), there will be no inguinal neck such as exists in the oblique, the hernia passing directly through the external ring down into the scrotum. This form of hernia has thus a more globular shape than the oblique.

When the *oblique* inguinal is reduced, the surgeon can pass his finger through the external ring along the inguinal canal upward and outward into the internal ring, and thus into the abdominal cavity, although in old herniæ the two rings are brought closer in apposition than in the more recent. In *direct* inguinal, the finger, having passed the external ring, seems to enter at once into the abdominal cavity, the opening being directly behind the external ring, and, with the finger passed through the neck, the external border of the rectus muscle may be felt on the pubic bones. By these points the diagnosis between the acquired oblique and the direct inguinal can be made out.

With respect to the points of difference between the "congenital" and "acquired" form of oblique inguinal hernia a few words are needed, and may be thus epitomized: The "congenital" form is *the* hernia of infancy and young adult life; the "acquired," that of middle life and old age. A hernia that has formed *suddenly and passed at once* into the scrotum is probably of the "congenital," whereas one that has been produced slowly is more likely to be of the "acquired," form. When the hernial tumor envelops the testicle and renders its detection impossible or difficult, the "congenital form" is indicated; when the testicle is in its right place and distinct from the hernial sac, the "acquired."

A hernia with a long tubular neck occupying the inguinal canal is probably of the "congenital" kind, a short thick neck being more common in the "acquired."

The youth of the patient, the rapidity of its formation, and its close connection with the testicle are the three chief points characteristic of the "congenital" form of hernia; the age of the patient, the slowness of its production, and its distinct separation from the testicle, the three points indicative of the "acquired."

The diagnosis of an inguinal hernia from other tumors is only difficult in exceptional cases. No scrotal tumor beginning in the scrotum and developing upward can be a hernia, for all herniæ descend toward the scrotum. So, when a distinct separation exists between the scrotal tumor and the external ring, no difficulty in diagnosis ought to be experienced. In this way ordinary hydroceles, hæmatoceles, and all diseases of the testicle are excluded.

When a *hydrocele*, however, passes through the external up to the internal ring—a condition by no means uncommon in infancy and young adult life—when the vaginal process of peritoneum is only closed at its abdominal orifice, some difficulty may be experienced; but in the absence of all symptoms of hernia the translucency of the tumor and the history of the case—viz., that the swelling began below and travelled upward—are sufficient to point out the nature of the affection.

Congenital hydroceles into the vaginal process are to be distinguished from congenital hernia by their transparency, by the gradual filling of the sac, and by their vibration on percussion; whereas a hernia is opaque, enters the sac rapidly, leaves it quickly, and does not vibrate.

An *encysted hydrocele* of the cord appears as a tense, fluctuating, transparent, irreducible tumor, and ought not to be confused with a bubonocele when no other symptoms of hernia exist beyond the swelling.

The wormy feel of a *varicocele* or varicose spermatic veins, and the fact that pressure sufficient to keep any hernia in position with the patient erect over the external ring renders the varicose veins more marked, should prevent it being mistaken for a hernia. And if the surgeon would only look for the two testicles in every case of scrotal, or even inguinal, swelling, he could not fall into the error of mistaking an undescended testicle or one resting at the internal ring or in the inguinal canal for a hernia or any other disease.

When a hernia and hydrocele coexist, some difficulty may be experienced in the diagnosis; but, as each affection has its own symptoms, the diagnosis ought not to be very difficult.

Whenever a doubt in diagnosis is felt about an inguinal tumor and symptoms of a strangulated hernia are present, the golden rule in surgery should be observed, and the doubtful tumor explored.

I had an interesting case (February, 1872) with the Messrs. Toulmin of Clapton illustrating this in a boy æt. 4 who had an acute hydrocele associated with a sudden descent of a hernia into the vaginal process of the peritoneum of the cord. I tapped the hydrocele and left the inguinal tumor, thinking it might be possibly a hydrocele of the cord, as no symptoms of strangulated bowel were present. These, however, soon appeared; and chloroform was given with a view of exploring the tumor, when, by the taxis, the hernia was happily reduced, and the boy recovered.

Inguinal hernia is very common in the female child; indeed, under puberty, it is the usual kind, and is always of the "congenital form," the bowel coming down into the open canal of Nuck. It is found, however, at all periods of life, though as a direct hernia it is only seen in the adult. The rupture may consist of the ovary and descend into the labium. It can be recognized by the same symptoms as in the male, and should be treated on the same principles. A hydrocele of the cord may be mistaken for a hernia.

Treatment.—A reducible inguinal hernia is to be kept up with a truss, whether in the infant, child, or adult; the truss, too, must be *well fitting*, exerting sufficient pressure to keep the hernia in position, *but no more*. In the adult the truss should always be moulded upon a cast of the groin taken with the hernia reduced. Should the hernia come down when the truss is on, it ought to be reduced and the truss reapplied. The pressure of the pad in the oblique form should be over the *internal*, but in the direct over the *external ring*. In infants a complete cure is often obtainable by these means in a year or so; and if no descent or any other symptom of hernia shows itself for another year, the truss may be left off. In cases of hernia occurring after infancy it is, however, never safe to leave off a truss. When some malposition of the testis complicates a case of the congenital form of hernia, care must be taken that the pad of the truss does not press the testicle; and when the testicle and hernia are both in the inguinal canal, the only truss that can be tolerated is one made upon a cast of the parts after rest, as already advised in page 530.

Irreducible, inflamed, obstructed, and strangulated inguinal herniæ are to be treated on the principles already stated.

A strangulated *direct* inguinal hernia is, however, a far more serious affection than the *oblique*, the sharp unyielding edge of the ruptured tendon surrounding the neck of the sac acting as rapidly upon the strangulated bowel as does the edge of Gimbernat's ligament in femoral hernia.

When a hernia cannot be kept up with a truss, the question of the operation for the *radical cure* of the hernia may be entertained. The operation has its dangers, and Wutzer, its early, and Wood, its present, advocate, admit that a truss is necessary subsequently throughout life.

The Radical Cure of a Hernia.

This has been the aim of surgeons from time immemorial, and were hernia only a mechanical lesion due to a weakness of the walls through which it protrudes or of the neck of the sac, some success would probably have attended the practice; but, as a rupture is more probably due to something more than this, it can hardly be expected that any very good result should have been obtained. Gerdy, Wutzer, Rothmund, Wells, and Davies have all tried to accomplish this by plugging the mouth of the sac with its invaginated fundus, Gerdy fixing the invaginated fundus by means of two sutures; Wutzer, by means of a cylindrical wooden plug passed into the inguinal canal in the hollow of the invaginated structures up to its neck, and a grooved wooden pad being applied

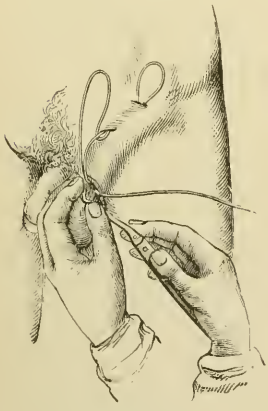
externally over the first to hold the parts in position, the two wooden instruments being held together by a needle (which is enclosed in the cylindrical part and made to pass through the internal ring and external tissues) and a screw; the plug should be retained for six or seven days. Rothmund, Wells, Davies, and others have only improved upon Wutzer's method. Mr. Birkett, however, tells us, on the authority of Dr. Otto Weber of Bonn, the late clinical assistant to Wutzer, that Wutzer is still of opinion that his operation is not dangerous when properly performed, and that by his method the fundus of the invaginated sac may be made to adhere to its neck; and, as a consequence of this, *if the patient continue to wear a truss for life, a return of the hernia may be avoided.* Dr. O. Weber, moreover, writes that he has never seen any of the so-called "cured cases" radically cured; that the plug of skin is by degrees entirely drawn out again; that the external and internal rings are not closed by the operation; that an imperfect cure may be effected by means of a partial closure by adhesion of the internal walls of the neck of the sac and thickening of the surrounding tissues. In London practice it is also well known that a fatal peritonitis has followed the attempt. With these facts before us respecting Wutzer's operation, I cannot recommend it.

Mr. Wood of King's College, believing that Wutzer's principle of practice was as wrong as his practice was unsuccessful, devised in 1863 an operation by which the hernial sac, without the skin, is invaginated into the canal, and the hinder and inner walls of the inguinal canal are drawn forward by means of sutures and fixed to the anterior and outer walls.

The steps of the operation are conducted as follows (they are taken from Druitt's *Vade Mecum* as revised by Wood):

The patient being laid on his back with the shoulders well raised and the knees bent, the pubes cleanly shaved, the rupture completely reduced, and chloroform administered, an oblique incision about an inch long is made in the skin of the scrotum over the fundus of the hernial sac. A small tenotomy knife is then carried flatwise under the margins of the incision, so as to separate the skin from the deeper coverings of the sac to the extent of about an inch, or rather more, all round. The forefinger is then passed into the wound and the detached fascia and fundus of the sac invaginated into the canal. The finger then feels for the lower border of the internal oblique muscle, lifting it forward to the surface. By this means the outer edge of the conjoined tendon is felt to the inner side of the finger. A stout semi-circular needle mounted in a strong handle, with a point flattened antero-posteriorly and with an eye in its point, is then carried carefully up to the point of the finger along its inner side and made to transfix the conjoined tendon, and also the inner pillar of the external ring. When the point is seen to raise the skin, the latter is drawn over toward the median line and the needle made to pierce it as far outward as possible. A piece of stout copper wire, silvered, about two feet long, is then hooked into the eye of the needle, drawn back with it into the scrotum, and then detached. The finger is next placed behind the outer pillar of the ring and made to raise that and Poupart's ligament as much as possible from the deeper structures. The needle is then passed along the outer side of the finger and pushed through Poupart's ligament, a little below the deep hernial opening (internal ring). The point is then directed through the same skin puncture before made, the other end of the wire hooked on to it, drawn back into the scrotal puncture, as before, and then detached. Next, the sac at the scrotal incision is pinched up between the finger and thumb and the cord slipped back from it, as in taking up varicose veins. The needle is then passed across behind the sac, entering and emerging at the opposite ends of the scrotal incision (Fig. 316). The end of the inner wire is again hooked on and drawn back across the sac. Both ends of the wire are then drawn down until the loop is near the surface of the groin above, and are twisted together down into the incision and cut off to a convenient length. Traction is then made upon the loop. This invaginates the sac and scrotal fascia well up into the hernial canal. The loop of wire is finally twisted down close into the upper puncture and bent down, to be joined to the two ends in a bow or arch, under which is placed a stout pad of lint. The whole is held steady by a spica bandage (Fig. 311). The wire is kept in from ten to fourteen days, or even longer if the amount of consolidation is not satisfactory. Very

Fig. 316.



From Wood.

little suppuration usually follows, but after a few days the parts can be felt thickened by adhesive deposit. The wire becomes loosened by ulceration in its track until it can be untwisted and withdrawn *upward*. In this operation the hernial canal is closed along its whole length, and an extended adherent surface is obtained to resist future protrusion.

After the operation, Wood says, a horseshoe pad should be worn for a few months; *and the truss is not to be thrown aside when the patient is about to be subjected to violent strains or lifting.* This is important to remember, though it tends much to do away with the value of the operation.

Modifications of the operation are employed for infants, etc.

The operation I have described is a subcutaneous one and is ingenious. It has, moreover, its dangers. Wood writes he has operated 337 times with 4 deaths, and out of 107 cases in which the results were known in 48 a failure followed and in 59 a satisfactory result was secured. Thus, in the most favorable light, there is one failure to one success and risk to life. It is to be feared, however, that a large number of these so-called satisfactory cures are only so when they leave the operator's hands, since Kingdon's *Reports* of the City of London Truss Society tell us that within ten years fifty persons who had undergone some operation for the radical cure had, in consequence of its failure, applied for trusses; and this number is large, considering the surgeons who perform this operation are not numerous nor the cases abundant.

For my own part, I believe that where a hernia can be kept up by a truss, and the patient is likely to remain in a civilized country where trusses can be obtained, an operation for the radical cure is not called for. To risk the life of a patient on the theory of a cure, when a truss, as a matter of safety, has to be worn subsequent to the operation, is both unfair and unsatisfactory.

When a hernia is reducible and cannot be kept in place by a truss, when a patient is going abroad where trusses are not to be obtained or only obtained at too great a cost, the operation for the radical cure may be undertaken. Indeed, under these circumstances, I have performed Wood's as well as Wutzer's operation with good success—that is, the patients who previously could not keep up their hernia, on account of the great size of the inguinal ring, were enabled to do so.

In the "congenital form" of inguinal hernia there seems a better prospect of success following the operation than in any other, and a better basis for the practice; for, "thus allowing nature to guide our procedure, we must make it a rule to select those cases in which her efforts have failed, and by acting as her handmaid we may reasonably hope to arrive at a successful result" (Birkett).

The corkscrew operation, known as that of Mr. Spanton of Hanley, is another subcutaneous operation of which I have had no experience. It seems to have been successful more particularly in children, and is worthy of an extended trial.

Mr. Spanton's object in his operation is to fill the canal itself with organized tissues and at the same time to approximate its tendinous boundaries. The operation I describe nearly in Mr. Spanton's own words:

The instruments required for the operation are a narrow-bladed knife for making the scrotal incision, dressing forceps and the screw instrument (or strephotome), shaped like a corkscrew, with a wide spiral which tapers somewhat toward its base. The point is flattened, but sharp, so as to transfix the tough tissues without tearing, and the handle consists of a movable bar, which it is sometimes convenient to leave in position, so as effectually to steady the instrument. In cases where it is intended to use a ligature by means of a screw a glass rod perforated with two holes at each extremity will be required for fastening the ends of the ligature. The patient should have an aperient and an ordinary enema previous to the operation, and, if necessary, the pubes should be shaved. The patient being anæsthetized, the operator, standing on the patient's left, makes an incision large enough to admit the forefinger through the skin of the scrotum over the fundus of the hernial sac, usually an inch and a half or two inches below the pubic spine. The sac with the fascial tissues covering it is then separated from the skin by passing the knife or handle freely around the internal surface of the wound, until a sufficient extent of it has been separated to permit the finger easily to invaginate the sac into the hernial canal, which is readily accomplished by pushing the sac with the left forefinger up to the internal ring. After carefully examining the condition of the parts within reach of his finger—especially with regard to the position of the blood vessels and the boundaries of the aperture—the operator retains his forefinger in the inguinal canal, thereby protecting the spermatic cord, which lies below his finger, and at the same time closing the internal ring, so as to prevent any protrusion of the bowel. Sometimes with a very patent ring it is

necessary for an assistant to place his finger externally on the groin to make perfectly sure of this, especially if there is any cough or struggling. It is, however, wiser to wait a few moments and to let the patient become quiescent before proceeding further. Then, holding the "strephotome" firmly in the right hand, the surgeon thrusts the point through the skin of the groin at that part of the surface which corresponds to the outer pillar of the internal ring, which is also pierced by the point, which now comes in contact with the left forefinger. Having given the screw a turn, the point is made to pierce the invaginated sac and pushed on through the internal pillar (conjoined tendon) as high up as can be safely reached, the left forefinger carefully guarding the point of the instrument throughout. Another turn is now made, causing the screw to pass through the invaginated tissues and across the pillars of the external ring as many times as the length of the canal and the nature of the case will permit. The left finger is gradually withdrawn as the point passes downward and outward through the opening in the scrotum, the spermatic cord lying behind and slightly compressed by the gradual tightening of the hernial canal. The point of the screw is then protected by a small india-rubber ball, and the handle lies flat on the outer surface of the abdomen. The scrotal wound is closed by a single wire or hair suture. A pad and soft bandage are then applied over the whole. After a few days—usually seven to ten—the parts become sufficiently consolidated, and the screw is then removed without any difficulty and an oiled pad and bandage kept applied until the parts are firm.

If a continuous ligature is preferred, the screw with a large eye at the point is passed in the manner already described, then threaded with the ligature when the point appears through the scrotal opening, and the screw is gradually withdrawn upward, the ligature following its track and occupying its place. In order to keep the ligature tight, each end is fastened to a glass rod, which lies on the groin until the parts are consolidated—ten to fourteen days usually; the ends are then cut off and the ligature remains. After the operation a pad should be worn as a support and to give time for the parts to become consolidated.

The most satisfactory cases are those of congenital herniæ in the young, and this operation is especially adapted for those in which the hernial aperture is large and the sac bulky or where a congenital rupture is of old standing. The more tissue we can securely invaginate, the better the result, as a rule; and when the pillars are soft and lax, it is easier to bring all the parts firmly together and to secure a firm, unyielding barrier. Experience alone can teach which are the most suitable cases for each operation. Mr. Spanton tells me that he has operated in over 60 cases and has had no death.

Within recent times an *open operation*, a method by dissection, has grown in favor, and I for some years have employed it in preference to Wood's operation. It consists of cutting down upon the sac, dissecting it out, tying its neck with carbolized gut or silk sutures, excising the fundus of the sac, and stitching up the abdominal rings with good silk or wire sutures. Where omentum is present I cut it off, after applying a ligature to its neck. In fact, as an operation for the radical cure of a hernia, I do what I and most of my colleagues at Guy's have for years done after an operation of herniotomy with good success. Wood tells me he has recently performed a like operation in about 53 cases with a good result. This open operation has been ably advocated by Banks, Guénod of Basle, Annandale, Franks, and others. Banks employs silver sutures.

References.—Banks, *Brit. Med. Journ.*, November 13, 1882; Annandale, *Edin. Med. Journ.*, vol. xxvi.; Guénod, *Thèse de Basle*, 1881; Franks, *Med. Press*, January, 1884.

Femoral Hernia.

This forms about one-tenth of the whole number of cases of hernia, and about forty per cent. of all cases of strangulated hernia. It is also far more liable to become strangulated than inguinal, and less likely to be reduced by the taxis. The taxis, moreover, is more prone to produce injury. Thus, one out of three cases of strangulated femoral hernia is reducible by the taxis, two being operated upon; and of these, forty out of every one hundred die, the operation after "recent hernia" being twice as fatal as it is after the "old," a strangulated femoral hernia going on more rapidly to destruction than any other, and a strangulated "recent" than an "old" hernia.

Femoral hernia descends from the abdominal cavity through the crural ring *inside* the femoral vessels. The free margin of Gimbernat's ligament bounds its inner side, and the sac, which is always "acquired," pouches downward beneath Poupart's ligament and emerges through the saphenous opening to the inner side of the falciform process of the

fascia lata. The hernia expands laterally, resting upon this fascia, and as it enlarges turns upward over Poupart's ligament, then in the direction of the crest of the ilium, very rarely spreading downward. Its long diameter will be transverse, and not vertical. The neck of the hernia will always lie *outside* the spine of the pubes or the tendon of the long abductor, while an inguino-scrotal or labial hernia will always be found *inside* these points. The deep epigastric artery and vein usually lie outside the neck of the sac and are free from harm in the operation, though, when the obturator comes off from the epigastric and arches over the neck of the hernia to dip down on its inner side toward the obturator foramen, it may be divided when a *free* incision is made.

Rare cases of femoral hernia occur external to the femoral vessels, as related by Partridge (*Path. Soc.*, vol. i.), as well as through Gimbernat's ligament, or with a diverticulum through the cribriform or superficial fascia. (*Vide* Birkett.)

Diagnosis.—The points already stated will enable the student to distinguish a femoral from an inguinal hernia.

A *psoas abscess* dilates on coughing and disappears or diminishes on the patient lying down, just as does a hernia; but it is usually placed beneath and outside instead of inside the vessels. It is often accompanied also by spinal symptoms, and on manipulation gives the sign of fluctuation from above to below Poupart's ligament.

A *varix of the femoral vein* may also in a measure simulate a hernia; but whereas, in a hernia, with the patient erect, pressure over the crural ring and vessels will prevent its descent, in varix it will cause its enlargement.

An enlarged gland ought not to be mistaken for a rupture, as the history of the case and concomitant symptoms generally mark its nature.

Cysts in the crural ring are doubtless difficult to diagnose, although from their always being in the same spot under all circumstances, and from their not being influenced by position, coughing, etc., they are unlike hernia. When associated with a strangulated hernia, they may complicate the case, but seldom lead to error.

Treatment.—Reducible hernia can be treated by a truss, the pad pressing in the hollow below and external to the spinous process of the pubes. The radical cure has been performed by Wood, Wells, and Davies, but it cannot be recommended.

Strangulated femoral hernia requires the most prompt attention, for the parts constricting the neck of the sac are so unyielding as to produce in a short period an amount of damage which is too often irreparable. In the application of the taxis the utmost gentleness should be employed, and the administration of an anæsthetic should always precede the attempt. In the reduction of an old femoral hernia the taxis rarely succeeds.

In reducing a femoral hernia by the taxis the surgeon should always remember the position of the orifice of the sac, for when it has turned over Poupart's ligament, any pressure on the tumor can only do harm. The tumor should be gently raised by the fingers and drawn slightly downward and to one side before pressure is applied, which must be of the mildest kind. If the slightest disposition to yield be shown, the pressure may be continued, because, when any of the contents of the sac are emptied, the probabilities of the reduction of the whole are greatly enhanced. If no yielding be felt in the parts, the taxis had better be given up and the operation performed.

In all operations for femoral hernia the reduction of the hernia without opening the sac should be preferred, and in "recent" hernia this "minor" operation is generally successful. The incision to expose the sac, consequently, should be a limited one. Luke suggested that "a fold of integuments is to be pinched up and divided by transfixing it with a narrow blade, so that the incision, when the skin is replaced, shall fall perpendicularly to the body, with its centre opposite to the depression which indicates the seat of strangulation." But this plan is, in a measure, dangerous, as I have seen Mr. Aston Key with the point of his knife, in perforating the skin-fold, divide all the tissues outside the sac, and even the sac itself, and I have known a less skilful surgeon open the bowel.

Mr. Gay advises "an incision rather more than an inch long to be made near the inner side of the neck of the tumor. The superficial fascia to be divided, and a director or *bistouri caché* introduced down to the neck of the tumor and through the crural ring by the least amount of force, and with the aid of a little gentle compression of the inner side of the tumor by the finger, the point of the bistoury may be insinuated between the sac and the pubic margin of the ring; the edge of the knife is then to be turned toward the pubes, and by projecting the blade the seat of stricture in that direction may be effectively divided." When a director is used, or the finger, the ordinary hernia knife may be applied in the same way.

Nothing can be more satisfactory than this operation when reduction is effected by it, and it should always be attempted. If it fail and the sac has to be opened, no harm can possibly have been caused by the proceeding, as the incision can readily be enlarged if necessary, the sac opened, and its neck divided. Any modification of the incision, however, may be made. The essential point is that the incision should be of such a nature as to allow the surgeon to reach with facility the neck of the tumor. In operating, the surgeon must also remember the fascia propria or fascia that is external and superficial to the sac, which will always appear as a well-defined sac on the division of the soft parts that cover it, and that may be mistaken for the true sac. On its division a layer of fat will often be found more or less lobulated, which is the subperitoneal fat, and beneath it will be found the true peritoneal sac. In Gay's operation, as already described, when the parts outside the fascia propria have been divided and the hernia cannot be reduced, there is no objection to the surgeon dividing the neck of the sac upon a director; and when this fails, the sac must be fully opened. The flow of a stream of serum will probably attend this step, and, as previously stated, the nature of the fluid will indicate the condition of the parts within. When intestine is alone seen, the director may be carefully introduced into the neck of the sac and the constricting orifice divided, the intestine being then reduced with the gentlest pressure. When omentum covers the bowel, it should be carefully raised and unravelled, and when an omental sac exists, it must be torn through or carefully divided and dealt with as previously explained. The neck of the sac should be divided outside the omentum. The less the parts at the neck of the sac are disturbed, the better, no introduction of the finger beyond the neck of the sac being necessary, and no passing of the director or hernia knife called for beyond the neck. When the neck of the sac has been divided and the sac has subsequently to be opened to ensure the reduction of its contents, it is seldom necessary to reintroduce the bistoury, the parts yielding enough to the finger to allow of the replacement of the hernial contents; for the less the neck of the sac is divided, the better. The surgeon should always be careful that the hernia is not reduced within the crural ring, together with the sac; if so, the sac must be brought down again, opened, and held *in sitû* whilst its contents are returned. The after-treatment of the case is to be based upon the principles which have been already laid down.

Obturator Hernia,

or hernia through the foramen of that name, deserves a notice, as its successful treatment can only follow its diagnosis. It is more common in females than in males, and is often unattended by any external evidences of its existence. Birkett has collected twenty-five examples of this affection, though in fourteen the hernia was not discovered till after death. In three only was a successful operation performed—by Obré in 1851, by Bransby Cooper in 1853, and by Lorinson in 1857. Mr. Cooper's case I had the good fortune to see.

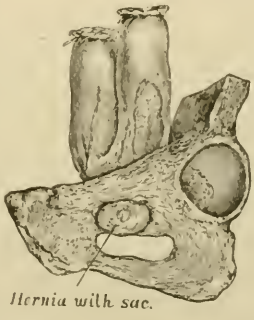
The sac of the hernia is always "acquired." It emerges in the thigh, beneath the pectineus and between the abductor longus and femoral vessels. The hernia is consequently on a lower level than the femoral and comes forward instead of downward. An obturator hernia is not, however, always to be felt, and a diagnosis has consequently to be made out of the general symptoms; and of these *pain in the course and distribution of the obturator nerve is the most marked.* It is not, however, always present. In several of the recorded cases, during the development of the hernia the pain described as "spasmodic contraction of the abdominal muscles" existed; and this fact is explained by Birkett in recalling the association there is between this nerve and the muscular filaments distributed on the abdominal muscles, all being branches of the lumbar plexus. Birkett also observed that movement of the hip-joint in the affected side excites or aggravates the pain, so does deep local pressure and pelvic examination, either *per vaginam* or *rectum*. In the following case, however, which came under my care in 1875, none of these symptoms were present, though a fixed pain in the left iliac fossa existed. Susan G——, æt. 65, a married woman, was admitted under my care into Guy's Hospital on the 26th May, 1875. She had enjoyed excellent health till 1871, when one morning, after considerable exertion, she experienced great pain in the left side and was able to sit down only with difficulty. The medical man who saw her said she had a hernia, but that it had gone up. Her health after this remained indifferent, though she was able to go about till six months before her admission, when she passed no motion for nine days and was very sick. Purgative draughts, however, acted upon the bowels very freely, and she convalesced. She then continued well until ten days before her admission. At that time no motion had passed

for ten days; she had continually vomited, looked very unhealthy, much emaciated and yellowish, was cold and collapsed, the abdomen being somewhat distended, with visible coils of small intestine and peristalsis. She also complained of diffused abdominal pain. No growth could be detected in the rectum. Opium was administered and warm fomentations applied to the abdomen with relief, and after four days the bowels acted twice spontaneously; and subsequently she had repeated loose evacuations. She left the hospital convalescent, though much emaciated, on June 15, 1875, nineteen days after her admission. She was, however, readmitted on December 26 of the same year, having remained quite well till December 3, though for the last three months she had been in much reduced circumstances. On December 3 she was again violently sick and had much pain in the *left side* of the abdomen, which was increased on passing a motion. The bowels were confined and the feces small. She had now a double femoral reducible rupture. Her abdomen was natural, and a rectal examination showed nothing abnormal. She was placed under the influence of opium, when the sickness ceased and the bowels acted. On January 6, however, the symptoms returned. She was again sick and had much pain in the left side of the abdomen, while the temperature rose to 101° F. From that time she gradually sank. The bowels were not again relieved; the abdomen became tympanitic and the vomiting ceased only a few days before death, which took place on February 4, with increasing exhaustion. She had at no time anything like obturator pain, and, though all the regions of hernia were carefully examined, nothing was noticed to suggest the disease.

Autopsy by Dr. Goodhart.—The body was very emaciated; there was no marked distension of the abdomen; the peritoneum was injected all over. A little pus was smeared over the coils in the neighborhood of the cæcum, and in the pelvis two ounces of pus or more had gravitated to the bottom of Douglas's pouch. No evident source of the pus could be discovered, though it is probable that it arose from periontitis due to overdistension of the bowel. The small intestine was only moderately distended, but crammed with pultaceous, yellow, fecal contents, and the coats were somewhat thickened. Following it downward, the distension continued till two feet from the cæcum, where a piece of the bowel passed through the left obturator foramen (Fig. 318). Below this the intestine was very contracted. The aperture in the obturator foramen was not large, and the intestine did not appear to be nipped in any way. A knuckle of bowel was in the sac, but the passage onward would not allow of the introduction of the little finger. The bowel was intimately adherent to the sac throughout, so that on opening the latter the bowel was wounded. The included bowel was grayish, but neither gangrenous nor inflamed. The mesentery was somewhat thickened at its neck and within the bowel were some old ulcerations, as judged from the amount of thickening of the edges of an ulcer found at the neck of the hernia. The ulceration, however, was not within the neck, but rather on the opposite unincluded surface of the intestine. The sac pushed the obturator nerve and vessels well to the outer side and to its upper part, with the exception of one branch of artery which passed to the thigh on the inner side.

The obturator muscle, which was in front of the sac, had to be scraped away to get at it. The sac was of nodular shape and about two-thirds of an inch in diameter (Fig. 317). It caused no fulness externally on the thigh. This was looked for particularly, because the protrusion was first discovered from the inside. In addition to the hernia, another coil of bowel (small intestine considerably higher up) was adherent by a strong band at the hernial neck, and about this the distended coils had twisted in a peculiar and indescribable manner; yet no obstruction had resulted therefrom, the distension continuing both above and below it. A slight femoral protrusion also existed on both sides. On the right side a little omentum was adherent at the neck of the sac, and by its adhesion dragged down the pyloric orifice of the stomach and the textures in the portal fissure.

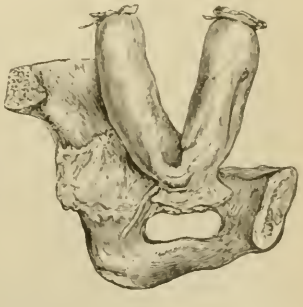
FIG. 317.



Hernia with sac.

External view.

FIG. 318.



Obturator Hernia.

Internal view.

Death in this case was clearly due to chronic intestinal obstruction caused by the adhesions of the bowel to the hernial sac. The only special symptom worthy of notice was the fixed pain in the left side of the abdomen, above Poupart's ligament.

TREATMENT.—The taxis can hardly be expected to be a successful proceeding in obturator hernia, the sac being so low down in the thigh and so little under control. Nevertheless, it should be tried, with the adductors relaxed by means of steady pressure applied downward in the hollow of the thigh and inward between the adductors.

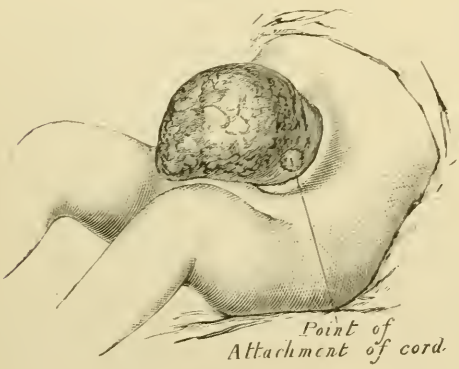
To explore the parts an incision should be made below Poupart's ligament and to the inner side of the femoral vein, down to the pectineus muscle, which may then be divided. If no sac appear and the obturator foramen covered by its muscle be reached, the fibres of this muscle must then be separated and the obturator canal found; for a small hernia, as proved by the case I have recorded, may be hidden completely by the muscle. When a sac is felt, the parts constricting it must be divided by a knife and its contents reduced. The obturator nerve should, if possible, be avoided.

UMBILICAL HERNIA.

This may be a congenital or an acquired affection, and is common in children from want of closure of the umbilicus. It is far from rare in fat women and in others who have had many children. It is also met with in men, forming five per cent. of all cases of hernia and six per cent. of cases of strangulated hernia.

The Congenital Form.—Children are occasionally born with a hernial protrusion of some of the abdominal viscera into the umbilical cord, the covering of the viscera consisting of the thin translucent sheath of the cord; this deformity is probably due to an arrest of development. Among the few examples of this affection that I have seen was one in which the liver projected, and in it the serous covering subsequently granulated, contracted, and so pressed the parts back into their normal position that a recovery followed. Fig. 319 represents the case in the fifth month. In the case of a male child one day old in which a hernia into the cord the size of a small egg existed, and through the thin walls of which the cæcum with its appendix was clearly visible, I pressed the bowel back with my finger and thumb, stitched up the cord at its umbilical orifice with some deep sutures, and ligatured the cord itself at the apex of the congenital translucent hernial sac; and complete recovery followed without any bad symptoms. The child was alive and well two years after the operation. The case was brought to me on June 16, 1876, by an old dresser, Dr. W. Cock of Peckham. The practice adopted in the case is that which I advise to be followed.

FIG. 319.



Congenital Umbilical Hernia.

The Acquired Form.—In the acquired form of hernia the *sac* is always formed, in both the infant and the adult, by the pushing forward of the parietal abdominal layer of peritoneum. The parts covering it, being occasionally very thin, are only integument and fascia, the internal abdominal fascia being over the true sac; at times the tumor attains a large size, and, as it generally increases *downward*, the surgeon must look for the neck of the sac at its upper part. These herniæ at times assume odd shapes.

TREATMENT.—When in an infant and reducible, a cure may with some confidence be promised; indeed, with the majority of cases in young life, an opening in the navel will contract if care be observed to fix with good strapping a *flat* elastic ring or pad covered with leather over the part. A convex pad tends to keep the ring open. A belt or truss in early life is a delusion, since it never keeps its place. In lieu of a pad, it is an excellent plan to pinch up the integument over the hernia with the thumb and finger and then to turn the folds sideways upon the umbilical opening, fixing it in its position by waterproof strapping, the folded integument by this method acting as a pad and assisting recovery.

Messrs. Lee, Barwell, and Wood have suggested an operation for the closure of the

umbilical orifice; but such a measure cannot be recommended, since to risk life unnecessarily for an affection that is mostly curable by time and natural processes assisted by art is hardly justifiable.

Adult patients with reducible ventral hernia should also wear some mechanical appliance, such as a ring truss; and an irreducible rupture should be protected by a truss made upon a cast of the rupture when at its smallest, after a day or so rest in bed.

When these tumors are large and irreducible, they give rise to troublesome abdominal symptoms. They supply, indeed, the best examples seen of so-called obstructed hernia. fæces and flatus enter the incarcerated intestine and remain immovable, causing nausea, colicky pains, and constipation. Rest in the horizontal position, the local application of cold, a good enema to empty the lower bowel, and a purge to clear out the upper, will often, under these circumstances, prove of great benefit, and should be tried in all cases.

When symptoms of strangulation exist, such measures, however, must not be thought of. The taxis should then be employed, and with a patient under an anæsthetic, as a rule, it proves successful. In applying it to a large tumor, where it is probable a fresh descent of intestine has taken place and the symptoms are due to its strangulation, the surgeon should examine the tumor carefully, to discover if one part is more tense than another, as then the taxis should be applied to the tense in preference to the other part. On several occasions, by adopting this practice, I have been able to reduce the strangulated portion of the contents of a hernia with complete success. When vomiting, constipation, local pain, and an absence of impulse in the tumor are persistent, the reduction or freedom of the mass from strangulation by operation must be entertained.

When herniotomy is called for, it is a matter of immense importance that no manipulation of the contents of the sac should take place, because, when the sac is opened and the parts exposed, it is an exceptional occurrence for a cure to follow, no cases of hernia under these circumstances being more fatal than the umbilical. When the sac is not opened, however, so as to expose its contents, or only opened at its neck to allow of the division of the strangulating orifice, a good result may be expected.

In many cases in which I have adopted this practice a good result followed, the oldest patient being seventy-four years of age, with strangulation of five days' standing.

In irreducible hernia of large size and of long standing, when reduction of the contents of the sac, as a whole, cannot be expected, and there is no evidence of strangulation within the sac by some of its contents, the surgeon should be satisfied with relieving the strangulation by dividing the neck of the sac and leaving the case to nature. To explore the whole sac and to expose the irreducible bowel to the air and manipulation are unnecessary as well as fatal. I had a case in 1874 with Dr. Brockwell of Sydenham in which, in a lady, an irreducible hernia of seven years' standing became strangulated; I simply divided the neck of the sac and left the parts alone. After two days the whole contents of the sac returned, and a rapid and complete recovery took place. I have followed this practice on several occasions with a similar result. A *double sac* is found at times in umbilical hernia. Some time ago I was called on to operate in such a case. The woman was aged forty-four and had been ruptured for years, the hernia being irreducible. She came under my care at Guy's with symptoms of two days' strangulation. The rupture was clearly inflamed, the slightest manipulation causing intolerable pain. Under chloroform I cut down upon the tumor and found two distinct sacs, their orifices, which were placed laterally, being separated by a piece of dense fibre tissue. One contained a mass of omentum; the second, intestine, which was black from congestion and covered with lymph. The orifices of the sacs were freely divided and their contents left, but the patient died, and no examination after death was allowed. In another case I found strangulated bowel in a small omental sac introduced into an irreducible hernia.

Ventral hernia is a term applied to any protrusion through the abdominal walls not belonging to the usual forms. Most of these herniæ are found in the linea alba above the navel. One of the largest I ever saw was over the right iliac fossa and followed a rupture of the abdominal muscles caused by a fall of twenty feet upon the handle of a pump; it was the size of a man's hand and strangulated. By the taxis I reduced the mass, and by the use of ice locally and opium internally the man recovered. He had, however, subsequently, to wear a pad to support the part.

After the operation of ovariotomy a very large protrusion may take place if a good belt be not worn. The same may arise after the weakening of the abdominal walls from abscess.

When the hernia takes place below the xiphoid cartilage, is is called *epigastric*, and in the loins *lumbar*. Birkett quotes two such cases. In 1875 I saw an example of the

epigastric form with Mr. Treves of Margate in a lady æt. 68 who had at the same time an irreducible umbilical hernia. Symptoms had existed for one hundred and eight hours when I operated, and the bowel slipped back unseen on dividing the parts at the neck of the sac. The patient, however, sank.

Perineal hernia descends in front of the rectum and appears in the perinæum, and is most common in women. When the hernia descends outside the vagina, along the ramus of the ischium, it shows itself in the labium—*labial* or *pudendal hernia;* and when it appears in the vagina, *vaginal hernia.*

Vaginal and labial herniæ may be mistaken for the mucous cysts of those parts, but the herniæ are reducible; and when irreducible or strangulated, they give rise to symptoms indicative of these conditions. The cysts are only local affections and cause no general symptoms. They are tense, elastic, globular tumors fixed in the tissues, and have *no neck* passing upward into the pelvis.

Ischiatic hernia is a hernia through the sciatic notch, above or below the pyriformis muscle. The gluteus maximus muscle covers it in, but as the hernia enlarges it may appear below the lower border of that muscle. Dr. F. C. Crosse in September, 1873 (*Dublin Journal of Medical Science*), has recorded an interesting example of this kind in a woman æt. 40. The tumor occupied the lower border of the right gluteal fold; it was the size of a fœtal head, soft and pulpy to the touch, dull in parts, tympanitic in others, and coughing gave an impulse to it. It was treated by a truss. When a rupture of this sort becomes strangulated, an operation must be performed, the surgeon making such an incision as will best expose the tumor and its neck.

Diaphragmatic hernia is met with as the result of an accident (traumatic), and is generally fatal; it has been alluded to under the heading of "Abdominal Injuries," page 491. It may also be the result of some "congenital" defect or the pushing of the abdominal viscera through a natural or other opening in the muscle (acquired form). It rarely calls for surgical aid.

On Trusses.

A truss is an instrument employed for the purpose of preventing the descent or enlargement of a hernia. It is composed of a pad, to be placed over the seat of the hernial protrusion, and a spring or belt, to keep it in position. Any truss that will keep up the hernia under all circumstances and does not cause pain or lasting discomfort is probably beneficial. Every truss that fails to carry out this object should be condemned. An instrument with a too feeble spring is a delusion and a snare, but one that is too powerful may tend to do more eventual harm than present good by causing absorption of the abdominal parietes, upon which it presses, and, as a consequence, enlargement of the opening through which the hernia descends. For the same reason a pad that is unduly convex is also to be condemned.

A pad, to be efficient and comfortable, should be moulded upon a cast of the part to which it is to be applied, since no two groins are alike. When this is done, the most perfect and most comfortable truss is provided (Fig. 304).

Every subject of a hernia, young or old, male or female, should wear a truss, and in a good proportion of cases, particularly of the young, a cure may take place—that is, the neck of the sac may close. But even after a cure or an apparent cure has taken place it is well, for the sake of safety, to wear the instrument, as cases are far from infrequent when a supposed cure has taken place, and after the lapse of years a sudden descent has occurred, jeopardizing life. This is the more common in the congenital form of hernia.

The truss should be worn all day, from the act of rising out of bed to that of retiring, as its object is to prevent the descent of the hernia under any sudden act of exertion, and with the truss off it is impossible to guarantee that any such may not be made. Some patients habitually remove their trusses when they are sitting in their drawing-room, but this practice is to be condemned, since I have more than once been called upon to treat a strangulated hernia which came down during some unguarded act under these circumstances; and it is in these unguarded moments that the truss is calculated to be of so much benefit.

When the truss is first applied, it will doubtless cause some inconvenience; with the moulded truss this is very slight. The use of plenty of starch or violet powder, the bathing of the point of pressure with some spirit and water, and attention to keep it very dry are excellent remedies for any little local source of discomfort.

The Pad.—This should be regulated according to the size of the hernial aperture,

a small opening requiring a small pad and a large opening a large one. The pad should always overlap for about half an inch all round the hernial aperture, and in large hernia for more. It should be adapted to the individual groin and be made flat or concave, according to its anatomy. It should also be so adapted to its spring as to keep its place under all circumstances.

In inguinal hernia it should, moreover, be so fixed to the spring as to exert a pressure at right angles to the plane of the hernial aperture. Thus, in large pendulous bellies the pressure may be upward or inward and upward, but in thin subjects directly backward. In femoral rupture the pressure should always be backward, in order to close the crural ring. Any truss that applies its pressure only in one direction must fail in its purpose in a large number of cases. It is, indeed, in this curve of the spring or direction in which the pressure of the pad is employed that the chief difference in the great varieties of trusses is found.

Some pads are rigidly attached to the spring that holds them in position, while others are connected by means of movable joints of different construction. Salmon and Ody's well-known truss has a ball-and-socket joint, as has the excellent Champion truss of America.

The spring of a truss is a matter of importance, although not so much as the pad and the direction of the line of pressure. Its strength should be carefully regulated according to the requirements of the individual case. It ought to be strong enough to keep the pad in position and prevent the descent of the hernia under all circumstances, but not so strong as to cause pain. The French spring consists of a coil like that of a watch-spring, is always in action, and presses inward. The German form is more rigid and inelastic and holds the pad firmly in its place, thereby resisting the protrusion of the hernia under any expulsive effort. The English makers employ a variety of springs. A too rigid one, as the German, is not to be recommended, whilst the French is also objectionable, its action being too severe and constant.

The best is that which holds the pad in position, keeps it there under all movements, counteracts any expulsive action of the hernia, and causes little if any discomfort. The lighter it is, under these circumstances, the better and the closer it is adapted to the body, the more comfort it affords.

The only truss that has no circular-body spring and is kept in position by a band is the Moc-main lever. The pressure is kept up by means of a thigh-strap attached to a small spring-lever connected with the pad. Such a truss is doubtless comfortable, as its action is not enough to produce inconvenience; but it is not safe under most circumstances. In old people, where the inguinal rings require only a little support it may be used; but in the middle-aged, when the hernia has a tendency to come down, it is a dangerous and unreliable instrument.

In **oblique inguinal** hernia the pad of the truss should be placed *over the internal ring and canal*, and not over the external ring, the object being to give support to the weak internal ring; in **direct inguinal**, it is placed over the external ring. In **femoral hernia**, when the crural arch is natural and not relaxed, a small pad may be employed over the neck of the sac; but when the arch is relaxed and movable, a large pad so adjusted as to press upon the ligament itself is required. After the operation of herniotomy for crural hernia this fact is worthy of attention; for when a free division of Gimbernat's ligament has been made, the neck of the sac is always large and the ligaments relaxed.

Varieties of Truss.—To give a description of every variety of truss is needless. *Egg's truss* is in all respects rigid, and keeps its place when once fitted. *Coles's truss* is very good, is light, and has a thin metallic pad covered with leather and acted on by spiral rings. When properly adapted, with a not too convex pad, it gives elastic pressure, but is not so well calculated to retain a hernia under violent exertion as another truss with a more solid pad, the elastic pad being apt to yield and allow the hernia to descend. This objection applies to all elastic pads, although air or water pads, in some cases, are very comfortable and valuable, particularly in the healthy aged subject.

Among the trusses with solid pads Wood's must be mentioned. They are made by Matthews, with flat pads, composed of wood, ivory, or vulcanite, an india-rubber water-bag being occasionally applied to the surface of the pad. They are held in position by a spring that encircles the body. The size of the pad varies with the nature of the hernia and the size of the hernial aperture. For oblique inguinal hernia the pad is of an obliquely curved horseshoe shape, the outer limb over Poupart's ligament being shorter than the inner, and the spermatic cord and pubic spine lying in the cleft. The curve of

the horseshoe is placed over the inner hernial aperture. For direct inguinal or umbilical hernia the pad is made the shape of an ovate ring, with a hole corresponding to the hernial opening in the centre. For femoral hernia the pad is egg shape. Newsom's truss has a thin round wire spring and a hard pad, which is very comfortable when well adapted. The truss of Dr. C. Edwards of Cheltenham is good, the pad being so arranged that it may revolve as well as slide on the spring when required. Those of Salt of Birmingham and of L'Estrange are also good instruments. Down, late Milikin, of St. Thomas's street, S. E., makes also an excellent truss, with a pad which, being movable upon a ball-and-socket joint is readily adapted to any case.

The best truss, without doubt, is the one already alluded to, with a pad made upon a cast of the groin of the individual requiring it, and fastened to a spring with adjustments like those of the American Champion truss, as made for me by Messers. Krohne (page 530).

The Main Objects of a Truss.—Whatever truss is selected to be of use, it must answer to a nicety the purpose for which it is required. The pad should be adapted to the abdominal hernial orifice or to the hernial tumor itself, and not below it. The amount of pressure applied to the pad ought to be carefully regulated, as well as its direction, and enough employed to keep the pad in position under all circumstances without causing pain, a slight force applied in the right direction being of more value than a greater misdirected.

The pad may be flat, concave, or slightly convex, and made of a solid or elastic material. A metal one with wash leather taking the shape of the parts is the best. Sand pads covered are of value, as they can be moulded to fit more comfortably and accurately than many others. For an irreducible hernia (not scrotal) the pad should always be framed upon a cast of the hernial tumor, taken when at its smallest, after rest. No other pad will keep its place.

To Test the Value of a Truss.—The patient should be made to cough and strain, and, when possible, to jump. He should be placed on the edge of a chair with his legs apart, or made to stoop forward with his knees apart and his hands resting on his knees, and then to cough, these positions tending more than any other to relax the lower parts of the abdomen and to loosen the truss. When the hernia by these means fails to descend or to excite in the patient a sensation of weakness in the region of one of the abdominal rings, the truss is probably efficient. The patient should be taught, under all circumstances, what the truss is expected to do, and be made to understand the danger he will incur if it fail in its purpose, as well as the necessity of again seeking advice.

The surgeon, moreover, should always take upon himself the responsibility of seeing that the truss fits, and not rest satisfied by sending his patient to buy a truss where he likes and of what kind he likes; he should also tell the maker what is wanted, and not leave him to find it out.

To Measure for a Truss.—The following points should be noticed—viz., the nature of the hernia, the size of the hernial aperture, the side, or if double. The circumference of the pelvis should also be given one inch below the crest of the ilium, and the girth of the body, commencing and ending at the hernial orifice, as well as the distance from the hernial aperture to the iliac spine. The surgeon, moreover, should always indicate to the maker the directions of the pressure required by the pad, and this should always be made out, when the patient stands, by a digital examination. In pendulous and fat subjects with inguinal hernia it may be upward, backward, and inward; in thin subjects, simply backward. In femoral rupture the plane of the crural ring is horizontal and may be closed by a backward pressure. No general rules can be laid down, though this is a point upon which the whole value of the truss depends.

To estimate the force required to keep the hernia in position is a difficult matter. Up to the present time the only true test is that of trial. Mr. Wood has had an ingenious pressure-gauge made for the purpose, which may possibly turn out of value (*Brit. Med. Journ.*, October 12, 1871). Mr. Holthouse has likewise invented a skeleton truss which promises to be of use for indicating the length and shape of the spring required and the correct angle at which the pad should be fixed.

Extra Spare Truss.—Patients who are liable to employ at times great muscular exertion should have two trusses—one, for ordinary wear, with a sufficient press power to keep the hernia in position; and the second with an increase of power, which is to be put on when occasion demands. They should also have extra bathing trusses.

When a Double Truss is to be Used.—When any tendency exists for a double hernia, as indicated by a bulging of the opposite ring or a sense of weakness on making exertion, a double truss should be worn: indeed, in inguinal hernia, I believe

that a double truss should always be employed. It is at least as comfortable as a single one, besides being an extra protection if well adjusted; certainly it can do no harm.

Birkett, *Holmes's Syst.*, vol. ii., 3d ed., 1883; *Med.-Chir. Trans.*, 1859.—Bryant, *Guy's Reports*, 1856; *Clin. Surg.*, part 3, 1861.—Cooper's *Surgical Dict.*, 8th ed.—Gay, *On Hernia*, 1848.—P. Hewett, *Med.-Chir. Trans.*, 1844.—Hutchinson, *Lond. Hosp. Rep.*, 1865.—James, *On Hernia*, 1859.—Aston Key, *On Hernia*, 1833; *Guy's Rep.*, 1842.—Kingdon, *Med.-Chir. Trans.*, 1861.—Luke, *Med.-Chir. Trans.*, vols. xxvi. and xxxi.—Lawrence, *On Ruptures*, 1835, 5th ed.—Stephens, *On Obstructed Hernia*, 1829.—Scarpa, Wishart's ed., 1814.—Ward, *On Strangulated Hernia*, 1854.—Wood, *On Rupture*, 1863.

CHAPTER XVI.

SURGERY OF THE ANUS AND RECTUM.

Malformations.

The anus and rectum are not rarely the seat of congenital malformations, which show themselves in a variety of forms. In one the anus is imperforate, the rectum being either partially or wholly deficient; in a *second* the anus exists in its normal condition, but opens into a *cul-de-sac*, the rectum being partially or wholly deficient (Fig. 320); and in a *third* the anal orifice is absent, the rectum opening into the bladder, urethra, vagina, or other abnormal position. And it will be observed, says Mr. Curling, to whom we are indebted for the bulk of our information on this subject (*Med.-Chir. Trans.*, vol. xliii.), that the classification of these imperfections is founded on states that can generally be recognized during life, although, unfortunately, the conditions of the terminal portion of the intestinal canal and its relation to the parts around cannot be predicated with any certainty, since in the first two classes of cases of imperforate anus or of anus opening into a *cul-de-sac* the intestinal canal may terminate in a blind pouch at the brim of the pelvis, the rectum being wholly wanting; or, as in the third class, an imperfect rectum may form and show itself as a short sac descending to the floor of the pelvis, or to the neck of the bladder in the male or the commencement of the vagina in the female. An explanation of these different conditions is to be found in the fact that these malformations are clearly due to some failure in the fœtal development and to the want of junction of the two ends of the rectal tube. The *anal* portion of the bowel, which develops from below, grows upward, while the *intestinal* descends from above; and these two parts subsequently advance and in a natural condition unite, the membranous diaphragm at the point of their junction disappearing at a later period by interstitial absorption. When a failure in this uniting process takes place, the *second* class of congenital imperfection is formed; when the failure occurs at an early period of development the two ends of the approaching tubes will be far distant, and when at a later period they may be in closer contact. The closure of the anal orifice is due to a firm adhesion of the integument.

Fig. 320.

Showing the Intestine ending as a *cul-de-sac* above the Anus. (Prep. 1882[75], Guy's Hos. Mus.)

Sometimes the blind pouch in which the intestinal canal terminates is connected with the anal integument or with the anal *cul-de-sac* by a cord prolonged from the bowel above, and it seems possible, from Curling's and MM. Goyrand and Friedberg's observations, that such cases are caused by an obliteration of the bowel, which was originally well formed, from some intra-uterine inflammatory action, instances being on record where the muscular tissue of the intestine was clearly traced into the cord. Where the upper bowel communicates with the urinary or vaginal passages, it is owing to the incomplete separation of the natural cloaca that exists during the development of those parts.

A clear understanding of the way in which these deformities are caused will explain the difficulties that are met with in their treatment.

Treatment.—On the birth of every child the condition of the different outlets of the body should invariably be examined; and even when the anus appears normal, a digital examination should be made on the second day if the bowels have failed to act, as many an infant's life has been lost for the want of this attention and the consequent postponement of surgical relief till too late a period.

In the *simplest* cases, when the anus is closed by a thin membrane and the bulging of the distended rectum indicates its nature, a cautious central incision through the soft parts should at once be made; and a good result is generally obtained, the power of the anus usually being complete. Mr. R. Harrison of Liverpool records the case of a child who was born with an imperforate anus, and was successfully operated upon in the anal region *thirty-three days* after birth (*Lancet*, February 26, 1876).

In the *more complicated* cases, where the anus is closed or absent and *no bulging of the bowel exists*, where the surgeon has no means of making out the true position of the terminal end of the bowel, a cautious incision may be made over the spot in which the anus ought to be found, the finger of the left hand acting as a pilot. The incision may be free as long as it is carried upward and backward toward the sacrum, and not forward toward the urethra or vagina. It must not, however, be made too high. Where there is not sufficient room to carry out this practice, the coccyx may be cut away.

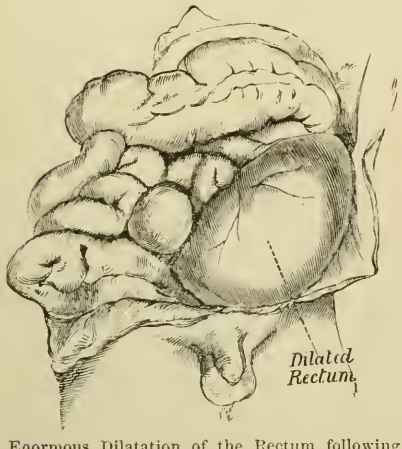
When these means fail, all further attempts must be relinquished. Blindly to introduce a knife or a trocar and canula upward with the vain hope of puncturing the distended bowel is a practice to be unhesitatingly condemned. Mr. Curling's figures, too, prove that the perineal exploratory operation, unless undertaken with great care, does more harm than good, though when skilfully performed it is followed by considerable success.

In the treatment of the second class of cases, when the rectum terminates above in a *cul-de-sac*, an exploratory operation may be made as just described; but the uncertainty as to the true position of the bowel renders any operative proceeding hazardous. When the two tubes are in contact and separated only by their membranous ends, as in the case illustrated (Fig. 320), a good result may be expected; but when they are far apart, no such success can be anticipated. Mr. Curling in his table gives 31 examples of this class of cases. In 27 an attempt was made to reach the bowel, in 16 with success, while 10 of these subsequently recovered.

When the bowel is opened in any of these cases and is not far from the anus, the surgeon should use all fair endeavors to draw down the intestine to the margin of the external opening and fasten it with sutures to the skin. He cannot often, however, succeed in accomplishing this, the bowel being rarely found at a less distance than an inch from the perinæum; but when possible, the advantages of the practice are great. Where this cannot be attained, repeated dilatation of the perforated bowel is absolutely essential to maintain its patency, as otherwise, like all artificial openings, its subsequent contraction will take place. The introduction of a finger once or twice a week is sometimes sufficient for this purpose, and in several cases I have had under care, where the tendency to contract rapidly was marked, the introduction of a large sea-taugle tent answered admirably, the tent being placed in water for a few minutes beforehand, to make it swell.

When the anus opens in an abnormal position, as in the vagina, and the anus made by the surgeon is established, there is a natural tendency for the abnormal opening to close, several cases being on record in which this result ensued. Three have occurred in my own practice. When success has followed any operative procedure in these cases, it is important that close attention should be paid to the condition of the bowel for many years, and, indeed, for the whole of life, because there seems reason to believe that the bowel which forms the upper *cul-de-sac* has but little muscular power and is liable to dilate under fecal collection, as well as to become paralyzed, death, under these circumstances, taking place from obstruction. In Fig. 321 this fact is illustrated. It was taken from William L——, æt. 26, who had been operated upon as an infant for an imperforate rectum. He died in June, 1874, from exhaustion and peritonitis following intestinal obstruction, this obstruction being clearly due to the narrowing of the rectum at the seat of the early operation. At the post-mortem the rectum was found to occupy half the abdominal cavity, and was thirteen inches long and eleven in circumference. Its walls were three times as thick as natural, more particularly the peritoneal coat.

FIG. 321.



Enormous Dilatation of the Rectum following Obstruction due to the Contraction of an Artificial Opening made into an Imperforate Rectum Twenty-six Years previously.

When the exploratory ano-perinæal operation has failed to give relief or when it is inexpedient to make the attempt from the very backward position of the genital organ, other measures must be adopted; and of these the opening of the large intestine through the abdominal wall is certainly the best. M. Rochard, in the *Mémoires de l'Académie Impériale de Médicine* (1859), gives ten authentic successful cases of Littré's operation in the groin for this affection. Holmes informs us, in his admirable work *On the Surgical Diseases of Children*, that he had not met with the account of any permanently successful operation since the publication of Rochard's paper. Guersant opened the colon in the groin eleven times in succession, and once in the loin, without saving a patient. Giraldès, however, had one case in which a child lived two months and a half, and then died from another cause.

The operation, to be successful, must be undertaken early, before the infant is exhausted and peritonitis has set in. Delay is justifiable only when the bowel is not distended and the symptoms not in any way urgent.

With respect to the form of operation, that known as Littré's is probably the best—viz., opening the bowel in the groin. The left groin is usually selected, Giraldès having shown from dissection that in thirty infants operated on for imperforation the intestine was found on the left in all (*Nouveau Dict. de Méd. et de Chirurg. pratiques*, 1864). Huguier has, however, recommended the right, on account of the frequent bend in the colon toward the right groin and the absence of the rectum in these cases. I have on three occasions performed Huguier's operation with temporary success. In the last case, operated upon in December, 1876, the child (a male) was twelve days old before relief was sought, and he lived eight days, dying from chronic peritonitis, which had evidently existed before the operation. The artificial anus had been made in the lower part of the large intestine; and had the operation been performed at an earlier period good success would probably have been attained. The question of side is, therefore, still *sub judice*. Amussat's operation in the loin is rightly put aside in these cases, on account of the natural looseness of the colon at this part in children and the very usual oblique turn of the colon after its splenic flexure. Figures likewise favor this conclusion, since, out of fourteen instances in which Littré's operation was performed, nine recovered, whereas two only out of seven recovered after the lumbar operation.

The operation itself has been described in page 508 ("Enterotomy").

In the treatment of the third class of cases, where the rectum opens into the vagina, the surgeon may lay open the rectum from the position of the natural anus, having previously passed a director into the vaginal orifice of the gut as a guide, drawing down, when possible, the bowel and fastening it to the integument by sutures, as originally performed with success by Amussat. As a guide to the perinæal incision a bent probe may be passed into the vaginal orifice of the bowel and the end turned toward the perinæum, cutting down carefully upon it. I have done this with success on four occasions, and in all stitched the bowel to the margin of the integument, forming a good anus. In two cases the vaginal orifice subsequently closed. In two that were operated on several years ago the patients have good control over their motions, while the vaginal fecal fistula seems to be contracting, liquid motions alone passing.

In exceptional instances the deformity, though persisting, seems to cause no inconvenience. Ricord has recorded one (*Gaz. des Hôp.*, 1863), in which the woman was married and her husband was quite unconscious that anything abnormal about the parts existed. Le Fort has recorded a second, in which the woman was married and had had three children, the malformation having been accidentally discovered in an examination for some suspected disease of the bowel.

"In such cases as these," adds Holmes, "the termination of the rectum in the vagina must be tolerably free, and there must either be an external sphincter or the internal sphincter must be hypertrophied."

When the *bowel empties itself into the bladder or urethra*, the case is very hopeless, though the prospects of a successful issue are better under the latter than under the former conditions. An exploratory operation in the region of the anus may, however, be made with the usual caution, in the hope of reaching the intestine, which when found may be dissected away from its attachments and brought down to its normal position. On the failure of this operation Littré's should be performed. Mr. Curling has related a successful case of Littré's operation in a boy eight years of age who had a good anus in the groin, yet suffered from the occasional passage of feces into the urinary passages.

By way of summary the following conclusions may be given:

1. In all but exceptional cases of imperforate anus, obstructed rectum, or misplaced

anus an exploratory operation in the normal anal position and an attempt to bring the bowel into its right place should be made, success following the attempt in nearly half such cases.

2. Such exploratory operations, however, to be successful, should be undertaken early and conducted with great caution, the line of puncture or incision being upward and backward toward the sacrum.

3. When these means fail or are inapplicable, the intestine must be opened in the groin (enterotomy), it being still an open question whether the right or the left side ought to be selected, though the latter is the usual one.

4. When an artificial anus has been made, its constant dilatation is a necessity.

For further information on this subject refer to CURLING'S paper, *Med.-Chir. Trans.*, vol. xliii., and French edition of HOLMES'S *Surgical Diseases of Children*, by DR. LARCHER.—BODENHAMER, WM., *On Malformations*, Wood, New York, 1860.—ASHTON, *On Rectum*, 3d ed., 1860.—CRIPPS, *St. Bartholomew's Hosp. Reports*, 1882.

INJURIES OF THE RECTUM.

The anal orifice and lower part of the rectum may be wounded by accident from falls or by design; and when this occurs, hemorrhage is a common result. Repair, however, rapidly goes on in these regions, and with the arrest of bleeding by either securing the divided artery or pressure and some simple dressing a good result may be anticipated.

In 1876 a severe example of this kind came under my care at Guy's Hospital in a boy æt. 12 who was impaled upon a rail, the iron spike entering the pelvis on the inner side of the right tuberosity of the ischium, perforating the rectum about two inches up, and lacerating the anterior wall of the rectum and base of the bladder. The injury was followed by collapse and attended with hemorrhage. I saw him directly after the accident, and made a free incision into his bladder as for lithotomy, in order to secure a free passage for the urine, it being clear that the recto-vesical peritoneal pouch was lacerated. Some, though not severe, peritonitis followed, and feces passed *per anum* as well as through the external wound. On the sixteenth day I consequently gave opium, to lock up the bowels, with the view of making a splint, as it were, of the feces, and to keep the rectum and intestinal wound quiet. Success followed the practice, and the wound in the bowel closed. After four days the bowels were opened by a dose of castor oil, and convalescence became established.

In parturition the rectum is sometimes laid open by a rupture, either alone or with the perinæum; and when this occurs, the rent ought to be brought together at once, for if this practice be not adopted a plastic operation subsequently will have to be performed. Cases are also on record in which, during parturition, the child's head passed into the rectum and was delivered *per anum*. M. Quème (*Revue de Chirurgie*, 1882) cites seven cases of this kind.

Laceration from Act of Defecation.—In the *act of defecation* small lacerations of the anus are not uncommon when the motions are very large or hard.

TREATMENT.—In the milder forms of laceration of this kind, cleanliness and laxatives, as a rule, are sufficient to allow the parts to heal. In some instances the rent does not heal and the case becomes one of fissured anus or painful ulcer of the rectum; and should be dealt with accordingly.

Wounds of the rectum inflicted by the surgeon, as a rule, heal readily, as is fairly proved by the cases of fistula in ano treated by operation and the recto-vesical operation for stone. The puncture made in the operation of tapping the bladder *per rectum* for retention also heals quickly.

It is well to remember that the rectum may be wounded by the passage of a bougie, enema syringe, or the introduction of an O'Beirne's tube. Guy's Museum contains specimens illustrating all these forms of injury, and at St. Bartholomew's there is a specimen of perforation of the rectum by a metallic clyster pipe through which gruel was injected into the peritoneal cavity.

Rupture of the rectum may occur during a violent effort at defecation, but there is no evidence to show that such an accident can occur when the bowel is healthy. In the majority of cases in which it has taken place some prolapse of the rectum was present. The rupture is usually in a vertical direction. It is known by the sudden appearance of a mass of small intestine protruding through the anus, following a sharp abdominal pain the result of an effort at defecation.

H. Mayo (*Dis. of Rect.*, 1833) relates the case of a lady who during a violent effort

at defecation felt something give way, and on the following morning discovered feces in her vagina. An examination revealed a rent two inches up the bowel large enough to allow the end of the finger to pass from the rectum into the vagina.

Foreign Bodies in the Rectum.

These may be introduced from *without*, either from mischief or from accident, and trouble may be experienced in their removal, their shape and position influencing the result. More commonly, however, they have been swallowed and have passed down the canal, becoming caught or impacted in the rectum. They are not unfrequently the cause of anal abscess, bones, pins, bristles, etc., being constantly found in the rectum under these circumstances. Stones, hairs, or husks may likewise form concretions that are foreign bodies. When large foreign bodies have been introduced into the rectum or concretions or solid masses of feces become there impacted, an anæsthetic should be given to allow of their removal, care being taken not to injure the walls of the bowel more than can be helped, since cases are on record where the foreign body has passed into the peritoneal cavity. With the patient under the influence of an anæsthetic the sphincters become so relaxed as to allow of the introduction of large instruments, or even the introduction of the hand to guard the bowel and remove the foreign body. Bottles, pots, cups, corks, rings, pencil-cases, bougies, sticks, stones, etc., have been impacted in these regions, and considerable care is needed in their removal, to prevent injury.

Treatment.—The injection of plenty of warm oil before the attempt greatly facilitates the operation. Lithotomy scoops or forceps are likewise valuable, but the ingenuity of the surgeon is necessary in every case to apply the best means to carry out the end in view. Linear rectotomy may be performed whenever it is called for, and occasionally the foreign body may have to be removed by laparotomy. M. Verneuil related such a case at the Société de Chirurgie, June, 1880. It was that of a man æt. 40 who introduced a piece of wood into his rectum to arrest a dysenteric discharge. A few days later, after the introduction of the hand into the rectum had failed to reach the foreign body, a median abdominal incision was made and the foreign body pressed downward, when it was seized and removed after the rectum had been incised from the anus. The man made a rapid recovery. Dr. Thorndike of Boston, United States, also records a successful case in which a large stone was removed from the peritoneal cavity after having passed into it through a ruptured rectum (*Rep. of City Hosp.*, 1882).

A large collection of such cases, with their treatment, is given by M. Morand in *Memoirs of the French Academy of Surgery*, vol. iii., by Ashton in his work *On the Rectum*, and by Poulet in a general treatise on foreign bodies in surgical practice (New York, 1880).

Diseases of the Anus and Rectum.

These have only recently received sufficient attention from the great body of surgeons, and, as a consequence, have been too often allowed to fall into the hands of "quacks;" and, although able and respectable specialists have since rescued this important class of cases from their hands, much remains to be done by the profession as a whole to bring the diseases of these parts into their right position—that is, into the hands of the general practising body of the profession. Again, in no class of cases are so many mistakes met with, and these almost always arise from a want of proper local examination of the parts. The anus or rectum is either unlooked at or unexamined from some mistaken notions of delicacy, or badly examined from want of knowledge or want of inclination. But such should not be, and every patient who complains of anything like persistent symptoms in those regions should be as carefully examined as he or she would be were any other locality equally affected. To do this some nicety is required, and to help the student the following hints may be acceptable.

Examination of a Patient.—The best position is on the side, with the legs well drawn up and the thighs flexed upon the abdomen, the hips being brought to the edge of the bed or couch in a good light; the surgeon, with one hand having uncovered the parts sufficiently to expose them, may then raise the upper buttock, and in doing this the anus comes well into view; in operations this may be done by an assistant. When an abscess exists, it will then be seen; if a fistula be present, its external orifice will be apparent. Fissures, warts, condylomata, or fleshy, flattened, cutaneous vegetations or cancerous tubercles will also be at once recognized.

Pendulous loose folds of skin about the anus will suggest the former existence of

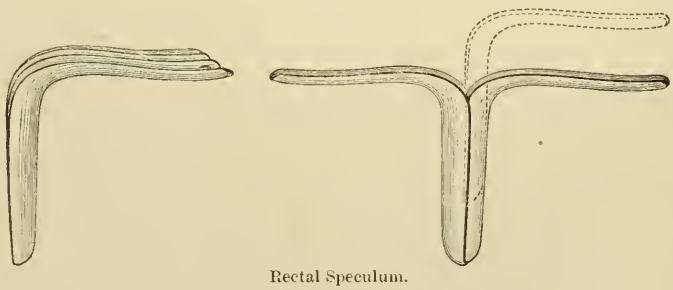
external hemorrhoids; blue, turgid, venous projections, their present existence. A tightly contracted and rigidly drawn-up anus, as a rule, means some painful ulcer of the part, and a patulous anus through which flatus or discharge passes without the patient's wish too often indicates extensive rectal ulceration or stricture.

Internal piles, when prolapsed, will appear as turgid, vascular, mucous projections covered with mucus or blood, surrounded by everted integument more or less œdematous; *prolapsus recti*, as a greater or less annular projection of smooth or rugous mucous membrane, with a central intestinal orifice. A *polypus* projecting will appear as a cherry, surrounded by healthy structures. All these points are taken in at a glance and understood. A digital examination should then be employed, to confirm or refute the suggestions thus taken in by the eye. To do this well the index finger must be thoroughly anointed with lard or ointment, it being a good plan previously to fill the nail with a piece of soap. It should then be applied to the anus and the patient told to bear down, as in doing this the sphincter is relaxed. The surgeon can then with ease and without pain introduce his finger. When an ulcer exists at the anus, pain will be caused by and spasmodic resistance offered to the introduction of the finger, and, with the pulp of the finger slowly moved round the anus, the ulcer will probably be felt. It should be stated, however, that in many cases this ulcer will be seen by a careful drawing down of the skin of the anus till the margin of the mucous membrane becomes visible. A spongy nodular feel of the mucous membrane just within the sphincter will suggest internal hemorrhoids; a local, tender, and raw surface, the probability of a simple ulcer; a circular, indurated raw surface, that of a syphilitic sore; while a cancerous ulcer is known by an infiltrated nodular and thickened surface. A stricture within two inches of the anus can always be detected by its annular form or the obstruction which it causes. When a healthy piece of bowel separates the anus from the stricture or ulceration, the probability of the disease being cancerous is rendered great. When no such healthy tissue exists, syphilitic disease is rendered probable. A digital examination will always detect the presence of scybala or impacted feces, and also the encroachment of uterine or pelvic tumors in women and prostatic tumors in men. To confirm these opinions thus formed, a speculum may be used, which should be introduced well warmed and greased in the same way as the finger. Mr. Curling says, "When the mischief is high up in the rectum, let the patient stand on the left leg, with the right thigh and leg bent, the foot resting on a chair. Tell the patient to strain. This action will then force the parts down." I have found this method of examination serviceable.

Mr. Allingham "advises the prone position, with the hips well elevated upon hard pillows, to such an inclination that the intestines will gravitate toward the diaphragm, so that when expiration takes place the rectum becomes patulous and you can see as far as the sigmoid flexure perfectly distinctly." This mode of examination, he informs us, was suggested by Dr. Marion Sims (*On Diseases of the Rectum*, 1882.)

The speculum represented in Fig. 322, as made for me by Krohne, is the one I prefer.

FIG. 322.



Rectal Speculum.

A nest of three. Two adapted for use.

The practice of introducing the whole hand into the rectum has been frequently adopted by several good surgeons, and from my own personal experience I believe it to be of value, more particularly for diagnostic purposes, in cases of suspected disease of the rectum above the brim of the pelvis, in pelvic or abdominal affections. In the female patient it is more readily performed than in the male. The operation, however, is neither easy nor free from risk, since laceration of the rectum has been recorded. It should be performed with the patient under the influence of an anæsthetic and with extreme slowness (five minutes may well be spent in passing the sphincter ani); the hand should be well

greased and introduced with a screwing motion. When the hand has passed within the rectum, much care is required; and when the narrowness of the gut forbids easy advance, no force should be employed, for by force the peritoneal covering of the bowel has been ruptured. With the hand in the rectum the parts above the brim of the pelvis may be readily examined; indeed, the kidneys have been felt, and pulsation in the larger branches of the abdominal aorta can be traced, and consequently controlled.

With these brief general remarks, I now proceed to treat of the special affections.

Fissure and Painful Ulcer of the Anus.

This most distressing affection produces more misery than any other local disease with which I am acquainted, and renders the natural act of defecation an agonizing one, often "causing great drops of perspiration to course down the temples." It is usually caused by the mechanical splitting of the orifice of the anus, from the passage of a large or indurated motion at the junction of the mucous membrane of the bowel with the skin, although it is not always traceable to such a cause. In some instances it seems to owe its origin to scratching the parts when highly irritable. It is usually a disease of adult life and common to both sexes, though it has been found in children even so young as a year and a half (*Brit. Med. Journ.*, June 6, 1874). It is met with as often in the healthy as in the feeble subject; but where it has been allowed to go uncontrolled, it soon tells upon the strongest patient. Constipation, high feeding, sedentary habits, and want of local cleanliness are the common causes, but anything that sets up irritation in the intestines is likely to produce it; and when once started, unless treated with discrimination, it may go on for years; indeed, it is by no means unusual to hear that the symptoms have been endured for two, four, or even six, years. It generally manifests its presence by some local uneasiness in the act of defecation, this uneasiness passing on to more or less severe pain. This pain, as a rule, is experienced during the passage of the motion, but in some instances it comes on after the lapse of a few minutes, or even an hour or more, after the act, and may last a few minutes or hours. When it passes away, the patient is easy till the same cause excites the same symptoms. The motions will often be streaked with a line of pus or blood and diminished in size, sometimes being flattened, at others, pipe-like; and this diminution is produced by the spasm of the sphincter, the size of a motion being, in disease as in health, greatly determined by the condition of the sphincter.

On examing the anus the first fact that strikes the observant eye is the unnatural resistance the patient makes on separating the buttocks, and, on doing this, the powerful contraction of the sphincter that will be visible. On attempting to introduce the finger considerable resistance will be encountered, and the greatest pain caused if the surgeon persevere in his attempt.

The symptoms and local signs of the affection are, indeed, so characteristic that the true nature of the case can, as a rule, be diagnosed without the aid of a digital *internal* examination, and a careful *external* examination will often reveal the presence of an ulcer on the verge of or within the sphincter; when within, the outer border only will be visible. The ulcer is usually, though not invariably, placed at the posterior margin of the anus, and is rarely larger than a sixpence, if so large. When recent it will be soft with slightly elevated edges, and when of long standing indurated with an irregular surface, small polypoid growths fringing its border. The ulcers are at times multiple, in exceptional cases involving the bowel higher up. It is an affection of the mucous and submucous tissue and painful only from its position, besides being obstinate in healing from its connection with the sphincter ani. Simple fissures of the anus rarely involve other than the mucous membrane and skin around the parts and are often associated with piles, though occasionally with small polypi. Ulcers are often hidden from view when piles or folds of skin exist about the anus, but pain indicates their presence.

In women this affliction is so often associated with reflective uterine symptoms as to be frequently overlooked, and in men urinary irritation may mask the disease.

Reflected nerve pains in the perinæum and down the leg, as in sciatica, or in the loins, as in lumbago, etc., are often induced by the affection.

Treatment.—Happily for patients, the treatment of this disease is as successful as it is simple. *Simple fissures* are readily treated by the administration of a laxative, the local application of the nitrate of silver or of lead lotion mixed with the extract of opium, and local cleanliness, with simple, nutritious, and unstimulating diet. When the parts are indolent or syphilis is suspected, black wash may be used, or calomel dusted over the

part or applied as an ointment of five grains to a drachm of lard. In other cases the application of mercurial ointment with the extract of belladonna gives relief. Injections of the decoction of rhatany twice a day, or of an enema composed of a drachm each of the extract and tincture of rhatany in five ounces of water, are sometimes of great use, as also is an ointment ten grains of iodoform to the ounce.

When a *larger ulcer exists* and is quite recent, the same treatment may be employed; but when the ulcer has existed for any time and has a hard base, it is quite exceptional for a cure to take place by these means, the surgeon being hardly justified in making the attempt when he has at hand such an efficient means as *the division of the base of the ulcer with the superficial fibres of the external sphincter*. This can be done in many cases by the introduction of the finger with a probe-pointed bistoury pressed flat upon it and introducing them to the upper margin of the ulcer, and then turning the edge of the knife toward the surface of the ulcer and incising it. Boyer, who first suggested this principle of treatment, advised the free division of the sphincter, but Copland and Brodie introduced the minor operation, which in the bulk of cases is sufficient to effect a cure. In very chronic instances Boyer's operation may be demanded. When an anæsthetic is given, a speculum may be used; and the ulcer, being exposed, should be divided by a sharp bistoury, transfixing the tissues at the base of the ulcer on cutting inward. The essential point of practice to observe is the free division of the base of the ulcer down to healthy tissue, the mode of doing it being unimportant. When any fold of skin or pile exists near the ulcer, it should be removed. The *forcible dilatation* of the sphincter and its laceration with the thumbs in the rectum, as practised abroad, is a barbarous treatment compared with the above, though when a patient is under an anæsthetic it may be followed.

After-Treatment.—In the after-treatment the bowels must be kept slightly loose, and for this purpose nothing equals in value a mixture of one ounce of olive oil rubbed down with forty-five grains of carbonate of potash and mixed with seven ounces of peppermint or chloroform water, one ounce being given two or three times a day, to produce a soft evacuation. Indeed, before as well as after the operation this mixture should be employed; when it fails, enemata ought to be used. The diet should be simple and rest maintained till the cure is complete, for where this rule has not been observed I have known the ulcer become so indolent as to require a second division, which under other circumstances is rarely required. Tonics are often of value during the convalescing period.

Spasm of the sphincter is not a disease, but a symptom, caused by reflected irritation from some rectal, uterine, or other local affection. It may be a small or superficial ulcer beyond the verge of the anus; the presence of worms, the existence of a small polypus, or some other local cause of irritation of the mucous membrane lining the bowel will be found after careful investigation.

The same remarks are also applicable to **neuralgia of the rectum**, though it is quite reasonable to believe that a pure neuralgia may occur of this part, as of any other. Yet, as a rule, it is caused by reflected irritation from some nerve with which the part is connected, and the surgeon should clinically so regard it. It is said to be common in gouty subjects, and can certainly be relieved by free purgation. At times it is caused by malaria and cured by large doses of quinine.

Anal Abscess and Fistula in Recto.

The two subjects of anal abscess and fistula in recto are classed together, as the latter disease is almost always preceded by the former, though a large number of cases of anal abscess recover without passing into a fistula. Of my notes of 236 consecutive cases of the two diseases, 43 commenced and ended as anal abscess, while the remaining 193 were treated as fistula in recto; 74 of these cases were females and 162 males, men being evidently more liable than women to this affection. It rarely occurs in children, though I have successfully treated a case in a male child four months old, and a second in one of fifteen months; in the latter the fetor of the discharge was very great.

Of the causes of this disease little positive information can be given, because, as a rule, the abscess is obscure in its origin and slow in its progress and repair, some patients even professing to have been unconscious of its existence till it was about to burst. In other cases, however, it is very *acute* in its action, and very painful.

That an anal abscess must always result from some ulceration of the bowel within the sphincter is an opinion which can scarcely be regarded as true, there being no evidence to support such a view; and the fact that so many as 43 out of 236 cases of anal

abscess recovered without forming a fistula goes far to prove its error. It is not unfair, therefore, to infer that in many cases it depends upon a different cause.

In fistula in recto this argument must be equally strong, since it is generally believed that this affection is merely the sequel of the anal abscess; we must, consequently, look for some other and more general cause than that ordinarily received—namely, perforation of the bowel from ulceration.

The mechanical irritation of a foreign body is doubtless an occasional cause, it being by no means uncommon for a surgeon to remove from the anus, when opening an abscess, a piece of fish-bone, bristle, or other foreign body. Quite recently I removed a pin.

These affections may occur at any period of life, though I have seen a fistula in a child four months old, and in the majority of instances it is found in adults between twenty and forty years of age. Dr. Lipscomb of St. Albans related a case to me which took place in his practice that was congenital, the mother having conceived when worrying about her husband, who was suffering from fistula. It is very common to be informed that the fistula had existed for several years before surgical aid is sought.

With respect to the connection between phthisis and fistula it is difficult to give any positive information. During the eight years that I was registrar at Guy's I inquired carefully into this point in every case, but had only 3 out of 193 in which either hæmoptysis or other symptom of marked phthisis was present. In the majority of cases the patients presented no more severe cachectic symptoms than is usually met with in other hospital patients, and I confess to being somewhat doubtful as to the fact that fistula in recto is a common consequence of phthisical disease. When, however, fistula and phthisis are associated, the former is usually of a bad form.

When a fistula has two openings, one externally and the other into the bowel, it is called *complete*. When there is an external but no internal opening to be found, it is known as the *blind external*; when an internal but no external, *blind internal*.

That, as a rule, an internal opening exists is now scarcely doubted, although at times there may be great difficulty in finding it. M. Ribes in 1819 examined the bodies of seventy-five people who died with fistula, and in all he found an internal opening; in nearly all this was placed just within the sphincter, but in no instance was it higher than half an inch. Modern surgeons now accept these facts. The pus that forms in these parts is very offensive at times, as often from the absorption of fetid gases through the mucous membrane as from the mixture of feculent matter. In a large number of cases the discharge has no fecal odor.

It should always be remembered that an anal fistula may accompany severe rectal disease, such as stricture or ulceration, or that it may be connected with disease of the pelvic bones, etc. In the case of an old man with an enormous abscess between the base of the bladder and the rectum constitutional symptoms were very severe till two deep incisions were made on either side of the perinæum, giving exit to a quantity of pus, when an excellent recovery ensued. In this instance it was a question whether the prostate gland was in fault, but no other symptoms of such a complication could be ascertained.

Treatment.—In cases of anal abscess *free incision* is the best practice, which should be made as soon as fluctuation can be felt externally or through the bowel. Deep-seated abscesses in these regions should not be left to natural processes to open. When the abscess is in front of the anus and rectum, an early opening may be called for, on account of the retention of urine to which it may give rise. The incision should be made from without inward in a line radiating toward the anus. In deep-seated abscesses one or two fingers may be inserted well into the rectum and the abscess pressed forward before the incision is made, a sharp straight bistoury being the best instrument to use. A piece of oiled lint should be inserted into the wound and kept there for a day.

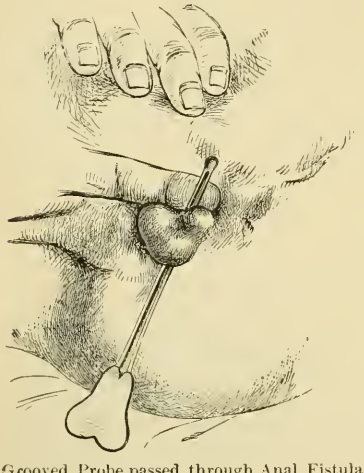
In a case I saw in 1872, owing to the neglect of making an early opening, emphysema and phlegmonous inflammation of the perinæum, scrotum, and penis, and of the abdomen even up to the axilla, took place, a free communication evidently existing between the bowel and the abscess. The patient died from the constitutional irritation of the disease. The sloughing of the cellular tissue was very extensive, and the fetor of the sloughs was something to remember.

After the abscess has been opened the patient should be kept at rest in the horizontal posture, some antiseptic dressing applied to the wound, and the most perfect cleanliness observed, laxatives being given when the motions are hard, and also tonics to improve the health.

When a *fistula exists*, the best operation is its division into the bowel, the action of the

sphincter ani having, doubtless, a powerful influence in retarding repair. The bowels should previously be cleared by a mild purge two days before the operation, and an enema given on the morning of its performance. The patient should be placed on the side upon which the fistula exists, with the legs well drawn up, and brought to the edge of the bed or couch. An assistant should separate the buttocks. The surgeon ought then to introduce a fine probe-pointed grooved director into one of the fistulous openings and with the greatest gentleness guide it through the fistula. Anything like force will excite resistance on the part of the sphincter to its introduction and cause pain. When the end of the probe passes into the bowel through the internal opening, all that is required has been effected; and if difficulty be experienced in doing this, the well-greased index finger of the opposite hand can be carefully inserted into the rectum and the internal opening felt for, through which, when found, the end of the probe can readily be guided into the bowel. When no internal opening exists (a rare condition), the director must be forced through the bowel at the upper part of the sinus.

FIG. 323.



Grooved Probe passed through Anal Fistula before its Division.

As soon as the director is felt in the rectum the patient should be told to strain, the surgeon at the same time with his index finger hooking its end downward. By these means the director will be made to protrude from the anus, when the whole of the tissues bridged over can be readily divided (Fig. 323).

When the fistula runs high up and much force is called for to turn the probe out of the anus, it is better to pass a speculum and to divide the fistula.

When a long sinus runs up by the side of the bowel, it should be laid open through a speculum, to leave it alone not being a safe practice; for, although in some cases a cure may take place, in many the discharge into the rectum will continue and but little good will have been effected by the external operation. The presence of this internal discharging fistula is generally indicated by the appearance of pus upon the motion.

When many sinuses exist, they should be laid open, although it is not necessary to divide the sphincter in more than one place, as a double division of the sphincter is apt to be followed by incontinence.

AFTER-TREATMENT.—After operation the wound should be well plugged with dry cotton-wool down to the bottom, and no careless introduction of the plug will suffice. By this measure all bleeding can be controlled, and any amount of pressure applied by means of a T-bandage. When no bleeding exists, only a moderate-sized plug is necessary.

On the second day the dressing may be removed, there being no occasion to reintroduce the plug, a piece of oiled wool or lint gently introduced to absorb discharge being all that is required. The wound should be kept clean. When indolent, it can be stimulated by some lotion of nitric or carbolic acid, terebene, or tincture of iodine, tonics and good diet being also valuable. The horizontal position—not in bed, but on a sofa—must be maintained, however, till the parts are healed.

In the *blind* internal fistula a guide to the external wound may often be found by means of a bent probe hooked through the internal opening, and the case treated as any other.

When severe bleeding complicates the case, a speculum may be passed and the vessel seized and twisted. Where this cannot be done the rectum may be well plugged with a sponge saturated in alum; but, as a rule, a well-applied pad and pressure, adjusted with a T-bandage, are sufficient to control it.

A piece of ice put into the centre of a cup-sponge and applied to the anus not only arrests bleeding, but gives great comfort in this, as in almost all anal operations.

When a cutting operation is inexpedient, as in "bleeders," or when the patient will not submit to it, the division of the fistula with a metallic wire heated by the galvanic cautery is a faultless method. Indeed, in all cases of fistula, where this apparatus can be obtained, it is the best means. It readily divides the tissues, the two ends of the wire being made to project through the two orifices of the fistula, thus burning their way out with a sawing movement. There is little pain at the time, and scarcely any after, with no loss of blood, and, what is more, no need of subsequent dressing, as a cauterized surface must heal by granulation.

When this plan cannot be followed, the treatment by ligature has been adopted. Mr. Luke revived the practice in 1845, but it has now fallen into desuetude. Were I called on to adopt the practice, I should use an india-rubber ligature.

In rare cases fistula may be treated by injection, a daily injection of the sinus with some tincture of iodine, sulphate of zinc, or nitrate of silver having been followed by a cure; yet such cases are too exceptional to justify the recommendation of such treatment.

When the patient's condition is such as to forbid any hope of repair in the wound taking place, the operation for fistula should be set aside; but the existence of pulmonary mischief, if not far advanced, is no argument against its adoption: nay, it may be made use of as an argument in favor of surgical interference, recent investigations, as already alluded to in an early chapter, having indicated that the long existence of suppuration is liable to set up tuberculous disease. Practically, however, it is undoubtedly true that fistula may be divided and heal in far from healthy subjects, and the general health improve after the operation.

There is no need to keep the bowels locked up after an operation for fistula.

Hemorrhoids, or Piles.

In a clinical point of view, these may be divided into the *bleeding* and the *non-bleeding*. The *former* are generaly the *internal*, and composed of a highly vascular tissue involving the mucous membrane of the rectum and the submucous tissue, with enlarged arteries and veins. Where the arterial element predominates, the tumor has a bright-red strawberry aspect; where the venous, a dusky hue. They are closely allied to nævoid structure and discharge arterial blood.

The **non-bleeding,** or **external,** piles are composed of the loose folds of skin that surround the anus, or a varicose, inflamed, or ruptured vein. When inflamed, these folds become œdematous and infiltrated with organized inflammatory products, and appear as fleshy growths of various degrees of density. The venous hemorrhoids also become swollen and appear as bluish, tense, and painful tumors. When in an active state, they may encroach upon the mucous membrane of the rectum and appear as large as a walnut, but, as a rule, they are about the size of a nut. They rarely give rise to much annoyance when cleanliness is observed, but under other circumstances they cause much local irritation. When swollen or inflamed, however, they give great distress, from the sensitive condition of the skin at these parts. External piles also are occasionally the cause of hemorrhage, the blood at times coming direct from an ulcerated vein and then being venous. At other times it will be profuse, but its exact seat is not so evident. The flow comes from between the pendulous flaps of skin, and ceases when they have been removed.

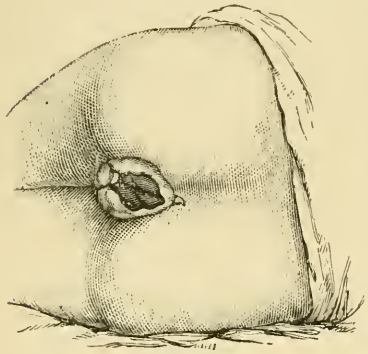
The TREATMENT of external piles is simple, and excision is the only radical cure. The pendulous flaps of skin that surround the anus may be removed with a pair of sharp scissors, the tumor having been drawn forward with a pair of forceps. These incisions should be made in lines radiating toward the anus. When coagulated blood has been poured out into the pile and a tense, painful tumor exists, it may be punctured or laid open with a lancet, bleeding, when it occurs, being easily arrested by cold and moderate pressure. When the pile is inflamed, leeching often gives comfort, and the application of a poultice covered with the extract of opium gives relief. When the part suppurates, the abscess may be opened.

In the early stage of the affection local cleanliness and abstinence from highly-seasoned food and strong wines are mostly sufficient, the bowels being kept clear by enemata or the occasional dose of a mild aperient, such as the compound rhubarb pill, before dinner, some saline, purgative water, or an electuary. When local irritation exists, an ointment composed of equal parts of zinc, nitrate of mercury, and subacetate of lead is very valuable; some recommend the compound gall ointment. An ointment of zinc and the extract of belladonna is very useful.

Internal piles are very insidious in their growth—so insidious, indeed, that bleeding is often the first symptom that attracts notice. On inquiry, however, it may generally be made out that constipation has been the normal condition, and that irritation about the anus, with a feeling of heat and fulness in the parts, had previously existed. These piles often appear after parturition. When the parts *inflame*, there will be throbbing, and pain in defecation; when they *protrude*, there will be one, two, three, or more masses of thickened mucous membrane with nævoid structure, presenting either a smooth and tense or a reticulated surface. Sometimes there will be oozing of blood from the

whole surface, or the blood may spurt from a distinct orifice. The blood is almost always red and arterial, and the mucous projection is surrounded by skin more or less pendulous, œdematous, or infiltrated with inflammatory products (Fig. 324).

Fig. 324.



Internal Hemorrhoids.

When the parts are not inflamed, this hemorrhoidal mass may protrude only during defecation and return naturally or after a little pressure. When the disease has been of long duration, the pile may protrude on the slightest exertion, even on the patient assuming the erect posture or on coughing, the whole mucous membrane of the rectum often participating in the prolapse and adding to the discomfort.

The *pain* attending the development of these piles varies vastly, small hemorrhoids often giving rise to severe local distress, while the larger cause but little. An inflamed pile is, however, always painful, and a prolapsed inflamed one the most of all. Where pain is excessive and more particularly felt after defecation, there is a strong probability that *a fissure or an ulcer* complicates the case.

The amount of *hemorrhage* bears no proportion to the extent of the disease. In one of the worst cases of hemorrhage I ever saw, in which a lady was blanched and almost pulseless, the pile was not larger than half a nut; it was of the reticulated kind, and the blood spurted out from a vessel as large as the radial artery. On the removal of the pile a complete recovery ensued On the other hand, it is remarkable to what an extent the local disease may develop in some cases without producing excessive bleeding.

The bleeding, as a rule, takes place after the action of the bowels and covers the motion; occasionally it precedes it; but in many instances it is quite independent of all action of the bowels, blood flowing on the patient assuming the erect posture or at odd times without any such cause.

The amount of blood said to have been lost under these circumstances is somewhat remarkable, writers upon these subjects relating the loss of three "chamberpotfuls," "eight or nine pounds," etc. Doubtless in many of these accounts there is exaggeration; still, all surgeons must at times be astonished at the loss of blood that takes place in these cases daily, sometimes for years, but with little apparent interference with the general health.

The discharge of a thick mucus from the anus is a frequent accompaniment of this affection; and when *ulceration* complicates the case, the secretion is of a mucopurulent character.

Urinary irritation, and at times **retention,** in both male and female subjects, and in women **womb complications,** often add to the distress.

Nerve pains passing upward to the loins, hips, and round the sacrum, or even downward to the heel and sole of the foot, are likewise met with. Brodie gives a case in which the heel pain was the most prominent feature.

What are called **dyspeptic symptoms** are almost always present, the assimilating organs suffering as well as the circulatory and nervous systems.

This affection is usually met with after puberty. In early life men are probably more liable to it than women, but after forty-five both appear equally liable.

Constipation has probably an important influence in causing the disease, and certainly in increasing it; but sedentary occupations and high living appear to have a stronger effect. In the prosperous classes of society this malady is comparatively common, although in the poor daily hospital experience does not help to confirm the notion that it is rare. Whatever tends to retard the flow of blood from the hemorrhoidal veins, such as pregnancy and abdominal tumors, aggravates the disease; and whatever tends to keep up irritation in the rectum, such as drastic purgatives, worms, and pungent food, acts in a similar manner.

A pile may be mistaken for a polypus, but the smooth, firm surface and pedunculated form of the latter will reveal its true nature. Again, a ring of piles might be confounded with prolapse of the rectum, but the uniform smooth and generally non-bleeding surface of the latter, with its broad attachments, ought to be enough to prevent falling into the error.

External piles, when ulcerated, may also assume very much the aspect of venereal anal outgrowths, which can be made out only by the history of the case and other clinical symptoms.

Finally, it must not be forgotten that hemorrhoids may be merely a consequence of another disease, such as stricture of the rectum.

Treatment.—All piles do not require removal. In the early period of their growth they may be so successfully treated by what is called *palliative* treatment as to render more active measures unnecessary, and in the very cachectic and diseased it may not be expedient to do more than relieve, although it must be added that unless organic disease exists to threaten life there are few general conditions of a patient that forbid the removal of a severe bleeding pile. Again, when piles occur in plethoric subjects who are perhaps what has been described as apoplectic or gouty, and an attack of them is preceded by constitutional disturbance and followed by relief; the surgeon should be careful in checking suddenly the flow of blood, as such a measure is undoubtedly sometimes followed by alarming constitutional symptoms, though such cases are rare.

The *palliative* or *general* treatment of piles means attention to diet, the giving up of high living and strong drinks, beer and spirits in particular being avoided, and the taking of simple nutritious food in moderation.

The bowels should be regulated by the mistura olei, already described (p. 568), or by castor oil, rhubarb and magnesia, or some saline medicine or mineral water, such as Vichy, Friedrichshall, or Pullna, and when these fail by enemata. Indeed, the daily enema of cold water or the use of the rectum plug, through which cold water is allowed to flow, is of great value. Violent purgation, more particulary by aloes and colocynth, should be avoided. Some prescribe copaiba, but its nauseous qualities forbid its general use. The confections of senna or sulphur are useful, and that of black pepper (Ward's paste) has been always popular. A mixture of confection of senna ℥j, confection of sulphur ℥j, powdered guaiacum ʒij, and treacle is very beneficial. The compound liquorice powder is of great use. Dr. Cleland recommends (*Practitioner*, January, 1876) the use of the liquor bismuthi ʒij, mixed with ℥j of starch, as an enema, to be used at night in prolapsus recti. In piles, in both the child and the adult, drachm doses of glycerine combined with fifteen grains of citric acid and some vegetable bitter three times a day may be administered.

When the secretions of the liver and intestines are unhealthy, a little blue pill or gray powder and chalk at bedtime is sometimes of use, some bicarbonate of potash in gentian or calumba assisting recovery.

Absolute local cleanliness should always be observed, and the recumbent position assumed after defecation, the prolapsed pile being always reduced at once by gentle pressure. By these different means an attack of piles may pass away never to return, or to return only after a long interval; but even in the worst cases relief may be given.

When the piles are inflamed, the application of leeches occasionally gives great relief, bleeding being encouraged by hot fomentations; such means, however, are rarely called for, the complete washing out of the lower bowel, rest, and fomentations being generally sufficient. In some cases the application of ice in a cup-sponge gives more relief under these circumstances than any other remedy.

When the prolapsed internal piles are strangulated by the sphincter spasmodically contracting around the mass, sloughing of the whole may take place. Under these circumstances great pain is caused by the tension of the parts, and on one occasion I was tempted to cut off with scissors some of the projecting portions, when the relief was so marked that I would repeat it under the same circumstances; to adopt this practice with safety, the pile must be in the condition that precedes its death. When this sloughing takes place, a cure may follow. During the sloughing process a poultice is the best application.

The mucous discharge from the bowel in long-existing piles can be met only by enemata and the application of astringents, such as an ointment of tannic acid ten grains to the ounce, of gall and opium, or of extract of rhatany half a drachm to the ounce of lard or spermaceti. The occasional introduction of a suppository of tannic acid into the rectum is likewise a valuable expedient, and an enema of alum or tannin five grains to the ounce is also serviceable. Allingham speaks highly of an ointment of the persulphate of iron half a drachm to one drachm of the unguentum cetacei, or, as a lotion, twenty grains to an ounce.

Surgical Treatment.

Unless the general condition of the patient forbids, all piles, external or internal, should be removed, not only when they give local annoyance, but when by the hemorrhage produced they disturb the general health of the patient and induce weakness. To accomplish this many means are at our disposal.

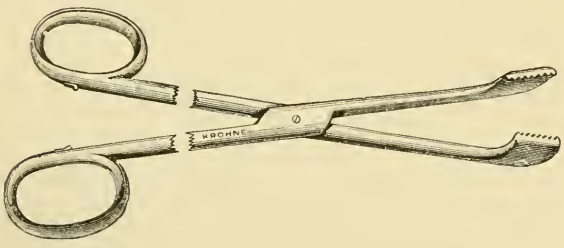
External *hemorrhoids* ought to be removed by abscission.

Internal piles ought never to be excised, but destroyed by the galvanic or actual cautery, crushing, or the ligature. In the hands of many surgeons the ligature still holds its ground, but with as many it has been nearly, if not altogether, superseded by crushing or the cautery. I have used the ligature only in exceptional cases for at least twenty years. In a few cases nitric acid is of service. In Paris a plan of treatment has been successful which claims attention, as it receives the support of M. Verneuil. It consists of forced anal dilatations, either by the thumbs of the surgeon or by means of a dilator, the piles withering after one full dilatation of the anus (*Union Médicale*, March 6, 1877).

The Ligature.—The patient, having made the hemorrhoidal tumors protrude by straining over a stool containing hot water or by an enema of warm water, should be placed on his side, with his legs drawn up and the parts well brought into view by an assistant separating the buttocks. The surgeon should then grasp the base of the tumor that is to be ligatured by a pair of forceps (Figs. 325, 326) and separate the pile from the skin and submucous tissue by scissors, subsequently transfixing it with a needle armed with a double silk or hempen ligature. He should then divide the cord and tie the pile tightly in halves, cutting off with scissors at least half of the strangulated portion before finally tightening the second ligature; a second or third mass should be similarly treated; the ends of the ligature should then be cut off and the whole returned within the sphincter. The surgeon should be careful to include in his ligature all the diseased tissue; and when this has not been done with the forceps, it is better to pass a needle or tenaculum through the base of the pile higher up, and loop a ligature round it, than to remove the forceps and reapply it. He should also take care not to include any of the external skin.

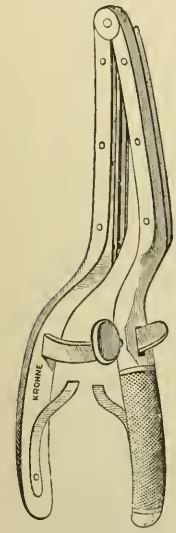
Fig. 325.

Fig. 326.



The ligatures may be expected to separate about the seventh or tenth day, and they should always be allowed to slough off.

Fig. 327.



Clamp for Hemorrhoids.

After-Treatment.—After the operation an opiate may be given, or a full dose of chloral (half a drachm). The bowels should be left undisturbed for at least two days, when a dose of castor oil or other purge may be administered, or, better still, an enema. The horizontal position must be maintained throughout the case. If œdema of the parts follow, ice may be applied, or a lotion of lead and opium; belladonna rubbed down with glycerine at times gives relief. Until the bowels act the diet should be simple, nutritious, but not stimulating. This operation is successful and has no special danger, though it is perhaps more tedious than the treatment by cautery.

The Cautery.—When internal piles require removal, the clamp and the cautery are means I generally employ; and the thermo or *galvanic* cautery is preferable to the *actual*. Cusack of Dublin suggested this practice in 1835, but Henry Lee and Henry Smith have done more to establish it than any other surgeons. It is adopted as follows: The patient having been prepared for the ligature and the piles protruded, the anus is to be dilated forcibly, with the view of allowing free manipulation of the piles, as well as of preventing subsequent spasm of the sphincter. Each mass is then to be seized *seriatim* with the vulcellum forceps, drawn down and secured at its base by clamps (that represented in Fig. 327, a modification of Curling's, being as good as any), the upper end of the clamps presenting toward the anus. The projecting half of each mass must then be cut off with scissors, the surface wiped dry, and the cautery, heated to a white heat, applied to the surface; the whole projecting portion being burned down to the level of the clamp; a dense eschar

is thus formed. When the thermo or galvanic cautery cannot be had, the actual cautery must be employed, a second being at hand to use as the first cools.

The eschar is more solid and firm after the thermo or galvanic than after the actual cautery; it is likewise followed by less pain, the heat being so intense as to destroy all sensibility. Ample experience with both has convinced me of this fact.

As each mass is destroyed the clamp should be removed, care being taken not to disturb the eschar. When all have been treated, the whole projecting mass may be returned into the rectum with the finger well greased, it being a good plan at this moment to introduce a suppository of opium or morphia to soothe pain.

After-Treatment.—Patients should be kept at rest for at least two weeks after this operation, but they will often be anxious to go about much sooner, saying that they feel quite well. A fortnight is the average time for convalescence, but a week in good cases seems sufficient. In one of the worst cases of internal piles I ever treated I applied the clamp to four masses and burned them down as described with the galvanic cautery. After the first day all pain had gone; on the fourth the bowels acted naturally without the slightest inconvenience, and in a week the man was up, no single drawback having taken place. Such a case, however, is exceptionally good even for the cautery.

The after-treatment is the same as in ligature, the local application of ice perhaps giving greater comfort.

Ignipuncture.—In not a few examples of internal hemorrhoids where one or two sessile masses alone existed I have by means of a speculum, without the aid of a clamp, applied the galvanic or thermo cautery to their surfaces direct, and in others I have merely punctured them in two, three, or more places, according to their size, taking care to rotate rather than pull on the cautery in its removal. Nothing but good results have followed the practice, and I am disposed to think that in such cases it is the best to adopt. Mr. Reeves has recently strongly advocated this method. A good sound eschar forms at once, and on its removal a recovery takes place.

Demarquay (*Gaz. de Paris*, 1860) merely passed a hot iron over the surface of the pile to produce a superficial eschar. He advised also linear écrasement where the piles only protrude on defecation and can be replaced, and where the sphincter is not relaxed nor the mucous membrane of the rectum prolapsed. In all other cases he prefers the cautery.

Treatment by Crushing.—This method was introduced into practice by Mr. G. Pollock (*Lancet*, July 3, 1880) and a clamp suggested by Mr. Benham employed.

The instrument is to be adjusted as in the operation for cautery, and the protruding pile cut off with scissors. The clamp, which is very strong, is left on the pile for one minute. Messrs. Pollock and Allingham have employed this method of crushing very largely, and speak favorably of it. It is said to be safe and to be followed by less pain than other methods. I have followed this practice in only a few cases, but have no reason to prefer it to the cautery.

Treatment by the Subcutaneous Injection of Carbolic Acid.—This method has been employed freely in America, and apparently with success. It is applicable to internal piles alone, and one pile should be treated at a time, about a week being allowed between the operations. About one to six drops of a solution of one part of carbolic acid in thirty of olive oil or glycerine should be injected with a hypodermic syringe into the pile, which turns white, and in successful cases withers without pain or sloughing. An ointment of vaseline should be smeared well over the parts around the pile, to guard against any injury from the dropping of the fluid. The majority of cases treated in this way, according to Dr. Andrews of Chicago, are cured rapidly.

When **nitric acid** is used, the patient should be prepared and treated in the same way as for the cautery; the acid should be applied with a piece of wood to the diseased surface. The spoon-shaped clamp forceps are probably the best to use under these circumstances. After the application of the acid the parts should be well oiled and returned. This practice was suggested by Dr. Houston of Dublin in 1857. To small, flat, strawberry-looking internal hemorrhoids this plan of treatment is applicable, but is not so satisfactory as the cautery. I never now employ it. Ulcerating piles may be treated in the same way as others.

When a fissure or painful ulcer coexists with hemorrhoids, its base should be divided before the operation for hemorrhoids is undertaken, or, what is better, lacerated by forcible dilatation of the anus.

In operating on internal piles the surgeon must be careful not to take the everted, and possibly œdematous, skin that encircles the mucous hemorrhoidal mass for external

piles and remove it. This should on no account be touched. Pendulous external hemorrhoids can also be taken away at the same time.

In rectal operations, when an anæsthetic is employed, the patient requires to be brought completely under its influence. It is probably advisable to use anæsthetics in all cases.

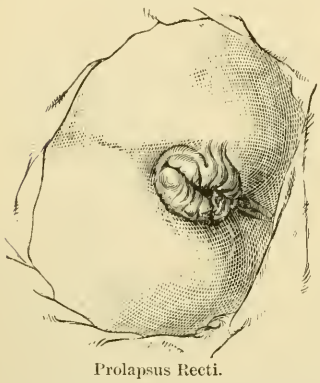
Local anæsthesia in these operations is worse than a delusion except for the removal of external piles, but it is of use to assist their reduction when inflamed and œdematous, and to give relief after operation.

The danger of operating is but small, though fatal cases have followed both the ligature and the cautery; the advocates of the latter say it is safer than the former. Mr. Henry Smith had only four deaths in four hundred cases operated on by the actual cautery.

Prolapsus Recti.

This is met with in every degree of severity, from the mere protrusion of a ring of *mucous membrane* through the anus (Fig. 328) to the prolapse of even a foot of *entire bowel*. In children a mild form is very common; it is usually a symptom either of some urinary irritation, such as a stone, or of a long or adherent prepuce; worms, constipation, dysentery, a *polypus*, or any rectal irritation may likewise induce it, as may a cough in very feeble subjects where the sphincter has lost its tone. One of the worst cases I have seen in an adult was due to the existence of a villous polypus high up the rectum; the straining accompanying the affection and the hemorrhage were very severe, but a rapid recovery ensued on the removal of the growth. In another case, that of a lady, where the bowel had come down for sixteen years, accompanied with daily hemorrhage, and in which walking was rendered impossible from the extent of prolapse (about six inches of bowel), the removal of the mucous membrane in three portions by clamp and cautery rapidly effected a cure. To ascertain the true cause of the affection, consequently, is the first aim of the surgeon, the treatment being then comparatively simple. On its removal the prolapse rapidly disappears.

Fig. 328.



Prolapsus Recti.

Treatment.—Whenever the bowel comes down, it should be returned; and this can usually be effected by placing the patient in the recumbent posture and pressing with oiled fingers flat upon the part. In children the utmost gentleness should be employed, for with pain resistance is produced, and with it increased difficulty in reduction. Under all circumstances the patient should be kept in the recumbent posture. The bowels should in children be relieved lying down, and in adults the horizontal posture ought always to be assumed after natural relief. Brodie advised nocturnal relief of the bowels to be encouraged with this object. When the parts have been down for some time, the greatest trouble is often experienced in their reduction; indeed, sometimes it is impossible, although, with the patient anæsthetized, success may attend the gentlest efforts when forcible attempts had previously failed. When the bowel has been reduced, a good pad or sponge fastened on with a T-bandage will keep it in place, or the nates may be fastened together with some good bands of strapping. When the bowel is inflamed or ulcerated—a condition that soon occurs in chronic cases when the patient goes about—some slight scarification may be called for; but the application of cold in the form of ice is probably the best treatment. In obstinate cases in children the free application of the nitrate of silver in stick to the whole mucous surface, previously wiped with lint and subsequently mopped, is often followed by its reduction and retention. I have never seen this practice do harm, and one application has often cured the disease. The injection of three or four ounces of water made astringent with tannic acid in the proportion of three grains to the ounce, or with tincture of iron ten drops to the ounce, or of the infusion of krameria or decoction of oak bark, with or without alum, after the bowels have been relieved, is a valuable adjunct: in adults the tannic acid suppository twice a day is useful, as also the application of the tannic acid glycerine before its reduction. A mixture of the solution of the perchloride of iron with two of glycerine is likewise a good application. Costiveness should never be allowed, either enemata being used to keep the bowels empty or the mildest laxatives, as rhubarb, castor oil, or some natural saline

water, as the Pullna or Friedrichshall. To give the bowel tone, tonics, as a rule, are required, nux vomica being probably the best, either alone or in combination with iron. I have never employed this drug in children, as the simpler tonics usually suffice, though some surgeons speak highly of it. In children, as an alterative, rhubarb, soda, and calumba mixed are to be recommended. In more severe cases of prolapse the application of nitric acid in vertical strips is very valuable, or, what is better, the thermo cautery, similarly applied. In bad cases it may be necessary to remove three or four vertical folds of mucous membrane with the clamp and cautery, as for piles. Few operations in surgery are more successful than this; and although in children it is probably never required, yet in adults it should never be rejected except for the same causes as operations for hemorrhoids. In very extreme cases of prolapse the linear cauterization of the prolapsed bowel may be advantageously employed.

The treatment of such a case would be precisely similar to that laid down in the last section for piles.

Polypus of the Rectum.

This is not so rare a disease as authors would lead us to believe. In the adult it is so, comparatively, but in the child it is *the principal cause of hemorrhage from the bowel*, and from this fact cases of polypus have been doubtless put down as those of piles. These growths are generally found in children under ten years of age, and in male more commonly than in female subjects, since out of 18 consecutive cases 14 were in males, 13 in children under ten, and 5 in adults. These growths vary in size from that of a pea to that of a large cherry; they grow from the submucous tissue and are covered by mucous membrane. When far beyond the reach of the sphincter and small, they probably do not cause any inconvenience, though when large they may give rise to straining of the bowel, to prolapsus recti, and even to intussusception. One of the worst examples of prolapsus recti I have ever been called upon to treat was due to the presence of a fibrous polypus situated some inches up the bowel of a man fifty years of age who had suffered from it for twenty years. He was cured by the removal of the growth. Mr. Pollock (*Holmes's Syst.*, vol. iv. ed. 2) has given a case in which intussusception took place, and in a case of my own the same result ensued. As it nears the sphincter local irritation and hemorrhage are produced, the growth appearing often at the anus as a pink or red cherry. Blood sometimes flows from the anus only during defecation, at other times quite independently of it. When the polypus is low down, there is usually with the blood a free discharge of mucus.

Whenever a child is brought with these symptoms, a local examination should be made; and to do this efficiently the surgeon should sweep his finger well into the rectum completely round the walls of the bowel. By doing this the polypus will be dragged from its attachment and its pedicle made tense. Sometimes several polypi exist together. I have on one occasion removed three. They are made up of fibro-cellular tissue, being more or less fibrous according to the age of the patient; in the adult the fibrous element predominates.

When polypi have been discovered, their removal is the only correct practice. In children, when I detect them with the finger, I generally manage to hook them down, and in so doing break them off. I have never seen any bleeding follow this measure. On several occasions, when I have brought the growth external to the sphincter, the action of the muscle has broken it away; and in this manner, doubtless, many cases of polypi are naturally cured. When they do not break off, a ligature may be applied to the pedicle and the growth cut off beyond the knot. In adults the ligature should always be employed.

On the removal of the disease the symptoms disappear; but when they continue, a second polypus will generally be found.

Papillary or villous growths are occasionally met with in the rectum, as in other parts of the large intestine; and when low down, they give rise to violent straining and hemorrhage. This straining may, indeed, give rise to an intussusception of the bowel or to prolapsus recti. This was well exemplified in the case of a woman æt. 43 whom I had under my care in June, 1867. She had suffered from prolapsus recti, with more or less bleeding after every motion, for twenty years, the straining at times being most distressing. When I saw her, the bowel was down for about nine inches: blood was then passing, and the pain was great. I made a careful examination, but failed to find anything. I reduced the prolapsus and prescribed rest. On my second visit, with the bowel only down a very little, I examined her again, and with my finger could just touch a new

growth. With a pair of long fenestrated forceps I took hold of it and brought it down, finding a splendid specimen of the villous polypus. I put a ligature round its base at

Fig. 329.

Villous Polypus of Rectum.

Fig. 330.

Fig. 330.—Vertical section of Polypus through the line *a*, Fig. 329, showing vascular simple and compound villi covered with a columnar epithelium, large vessels in the base on which the villi rest, and sections of the follicles of Lieberkühn. This section represents half the thickness of a lobule of the polypus seen by 1½-inch power. (Dr. Moxon's *Report on Villous Growth*, with drawings.)

once and cut off the growth. No single unfavorable symptom subsequently appeared; all her former troubles at once vanished, and a complete recovery ensued. In June, 1870, this woman was still well. The growth is illustrated in Fig. 329, and its microscopical appearances in Fig. 330.

Condylomata are also very common about the anus, and are mostly, but not always, syphilitic, the irritation of dirt being probably sufficient to produce them. In children they seem to come from the irritation of worms.

Treatment.—Cleanliness, the application of nitrate of silver, and the dusting of their surfaces with calomel or oxide of zinc generally produce a rapid cure. *Vegetations* due to the irritation of acrid discharges, such as *gonorrhœa* or *syphilis*, require to be excised.

Warty growths are also met with about the anus, as on other cutaneous surfaces. Sometimes they grow to a great extent, and then require excision. I have removed a mass the size of a fist.

Pruritus ani should generally be looked upon as a symptom of some rectal or intestinal irritation, constipation, or rectal disease. It is always a source of great distress, the most distressing cases being those in which the symptoms occur at night in bed, preventing sleep. The best application I know for its relief is a cold sponge, and, having dried the parts, the ointment made of equal parts of zinc, nitrate of mercury, and subacetate of lead ointments. Zinc and opium ointment is also beneficial. The application of cold through the rectum plug may also be recommended. These remedies, however, only relieve the symptom; in order to cure it the cause must be found out and removed. If ascarides be the cause, Agnew advises an injection of carbolic acid and olive oil (one part to six), and in obstinate cases an enema of bromide of potash ʒss dissolved in cosmoline ʒiv; in nocturnal pruritus, iodoform gr. iij or iv as a suppository. When due to the presence of minute cracks and fissures, a solution of nitrate of silver gr. x to xx in an ounce of spirits of nitre is good.

Ulceration of the Rectum and Stricture.

The painful ulcer of the anus or anal orifice of the rectum has been already noticed, and it remains for us to consider briefly such other forms of ulceration of the rectum as are met with in practice. They may be described as *simple*, *syphilitic*, and *cancerous*. *Simple* ulceration is by no means unfrequent; and when not involving the anus, it gives rise to symptoms which are usually looked upon as dysenteric. The passage of lumpy feces with blood and muco-purulent discharge is the chief symptom. The rapid passage of the intestinal contents through the sigmoid flexure and rectum gives rise to a slight griping pain, but beyond this there are few general symptoms. On examining a rectum under these circumstances a single ulcer will probably be found, but occasionally others. It may be somewhat indurated at its edges, though its base is not so as a whole. It is often circular, and at times surrounding half the rectum. In the case of a boy æt. 16

under my treatment the surface of the ulcer was so nodular that I should have suspected its cancerous nature had I met with it in an adult, but in this instance it had existed for many months, and the granulations had assumed a polypoid nature. It ended in a recovery. These simple ulcers are also likely to perforate the bladder and to induce recto-vesical fistula. I have had five such cases, and in four colotomy was performed with success, the operation taking away the chief source of distress—viz., the passage of feces with the urine—prolonging life, and apparently allowing the ulcers to heal. (*Vide* paper by author, *Clinical Soc.*, 1872.)

Treatment.—These cases can be treated by general means, such as a careful regulation of the diet, alkaline medicines with tonics, the administration of laxatives, such as the mistura olei, to cause and maintain a soft condition of the feces, and the daily administration of a small two-ounce enema of starch and opium or simple oil. The recumbent position should be maintained as much as possible.

Under these circumstances a good recovery generally takes place.

When these ulcers involve the anus, they give rise to the same painful symptoms as the painful ulcer of the anus and must be treated in a similar way—viz., by division of the superficial fibres of the sphincter.

Syphilitic disease of the rectum is a more common affection and is met with in both sexes, though more frequently in women than in men, the disease apparently creeping from the vagina to the rectum. Occasionally it is due, doubtless, to direct introduction of the poison. It appears as a more or less extensive ulceration of the lower two inches of the rectum, and, as a rule, involves the anus, as well as passing higher up the rectum. It is a disease of the mucous and submucous tissues, and is indicated in its early stage by a spongy induration of these tissues, and later by ulceration and the discharge of a highly irritating, sero-purulent, or sanguineous discharge and by a patulous anus. The anus itself may also be the seat of the lateral, flattened, fleshy, cutaneous outgrowth so common in syphilis, or it may be ulcerated. It is generally a disease of young adult life and associated with some syphilitic history.

Symptoms.—There is almost always some pain in the act of defecation, some looseness of the bowels and discharge of blood, pus, or mucus. Anal or vaginal fistulæ sometimes complicate the case. In neglected cases, where cicatrization has gone on with spreading ulceration, there may be constipation and some stricture; indeed, as a cause of stricture of the rectum, this syphilitic disease is by no means unusual.

Treatment.—Recognizing its syphilitic origin, large doses of the iodide of potassium ought to be given—five grains, gradually increased to ten or twenty, three times a day—in some bitter infusion or bark; but when tonics are indicated, they may be given in combination. The bowels should be kept slightly loose by the daily dose of olive oil or castor oil, so regulated as not to purge, and the daily employment of an enema of starch or gruel, with or without oil, to keep the parts clean and free from the irritation of feces.

The recumbent posture should likewise be observed, and simple, nutritious, but not bulky, food taken.

Locally, absolute cleanliness is essential. Where contraction exists or is taking place, the daily introduction of a bougie anointed with some mild mercurial ointment such as the unguentum metallorum may be used, but for the patient the daily introduction of a candle similarly anointed is preferable, candles being made of all sizes. Nothing like mechanical dilatation should be thought of, as it is dangerous in the extreme. By these means a cure may be effected, though such can only be complete after the treatment of months. In very neglected or severe cases a cure is almost hopeless without colotomy. I have had some striking examples under my care illustrating well the advantages of this operation. The recognition of the disease as syphilitic is the main point of importance.

Foreign authors describe *chancroid* disease of the rectum as venereal, and not syphilitic; but in this country it is hardly recognized. Such may, however, be found amongst the cases described as simple ulceration.

Cancerous ulceration of the rectum, usually **epithelial,** sometimes villous, rarely carcinomatous, is generally met with two or three inches up the bowel. It occasionally occurs higher up and beyond the reach of the finger in the rectum, and occasionally lower down, nearer the anus or involving it. It is remarkably insidious in its origin and uncertain in its progress, giving rise at first only to such symptoms as are usually put down to constipation, for this symptom is the most prominent feature, while the occasional pain and bearing down or straining are looked upon as the result of the constipation. In a general way, it is only when some blood or sero-purulent fluid has passed,

with or without a motion, that surgical aid is sought: and it is under such circumstances that the surgeon discovers, on making a local examination, that such a serious disease exists.

The cancerous ulcer can rarely be overlooked and occurs as an indurated, nodular, irregular mass. In its early stage the surface may be smooth; in a later, irregular, from ulceration; the discharge, which is generally very offensive, is made up of broken-up tissue, blood, and thin pus. The disease involves, as a rule, the whole circumference of the bowel; at others, only a part. It is always associated with a narrowing of the canal, which will go on to cause its complete occlusion. It generally attacks patients past middle life, but it may be found in the young. I have seen it in a boy æt. 15, and in September, 1871, I attended, with Mr. Turner of Bermondsey, a girl æt. 18 who had had insuperable constipation for seven weeks. I opened her colon in the *right* loin with great relief, and she was up and about in six weeks. She died ten months after the operation (June, 1872) with a rectum *completely occluded* from cancerous disease, and with secondary tubercles in the pelvic peritoneum. The disease was examined at the Pathological Society by the committee on morbid growths, and was found by Dr. Hilton Fagge and Dr. Goodhart to be of a cancerous nature, confined to the peritoneum and ovary, and only leading to stricture of the bowel by a secondary process of contraction. The stricture has an ulcerated surface, but the mucous membrane did not show any cancerous elements (*Trans. Path. Soc.*, 1875).

Treatment.—Palliative treatment can alone be thought of, such as the maintenance and improvement of the general health by diet and tonics; the removal of all local causes of irritation by the use of laxatives, to render the motions more liquid, and consequently more easy for evacuation; and the relief of pain by the use of enemata of starch and opium or by morphia suppositories.

In the very early stage of the affection, before ulceration has taken place, the use of bougies may be justifiable and useful, but when ulceration exists they are injurious and dangerous. When the obstruction becomes a symptom of importance, surgical treatment will have to be thought of; but this will be considered under the heading "Stricture of the Bowel."

Complications of Ulceration.—All cases of ulceration of the rectum may go on to cause stricture; the cancerous cases to a certainty must, the syphilitic often do, and the simple may when extensive. The two latter cause a *cicatricial* stricture resulting from the contraction of the cicatricial tissue in the mucous and submucous tissue, the first producing a stricture by simple increment. They may also be complicated with deep-seated abscesses and fistulæ and with hemorrhoids. The surgeon should, therefore, always be careful, when treating these affections, to examine the rectum minutely, as it is only too common to meet with cases that have been subjected to useless operation for piles and fistula when these affections were the results of a far more serious disease, such as stricture or ulceration of the rectum.

Again, any of these forms of ulceration may extend into the bladder or urethra. I have had five examples of such cases of vesico-intestinal fistula under my care in males and one in a female, in all of which the agonies of a foreign body in the bladder were added to those produced by the ulceration, and in the four male cases complete relief was afforded by colotomy. In three of these the ulceration seemed to be of the simple kind. In another the existence of rectal ulceration was first revealed by a sudden rush of urine through the rectum after an attack of retention.

I have seen many cases of recto-vaginal fistula as a consequence of syphilitic and cancerous disease.

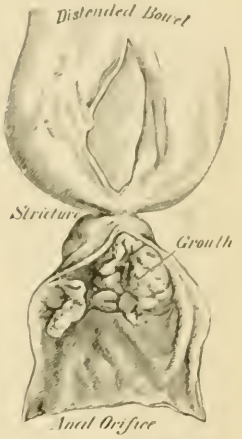
Stricture of the Rectum.

In the majority of cases this is caused by cancerous disease; in many it is the result of an inflammatory process, simple or syphilitic, from the cicatrization of deep-seated and extensive ulceration; in others it is due to the contraction of inflammatory material poured out in the submucous tissue; in exceptional instances it may arise from contraction of the parts external to the bowel after pelvic cellulitis: and Curling quotes a case where it was the direct result of an injury.

In all these conditions the calibre of the intestine is gradually or rapidly encroached upon, till at last complete obstruction takes place. The stricture may appear after death as an *annular* contraction of the bowel with adventitious material in the submucous tissue and hypertrophy of the muscular coat, looking very like a so-called scirrhous pylorus, or as a thickened, ulcerated, irregular mass of cancerous material infiltrating all

the tissues of the bowel although rarely extending beyond two or three inches in length. The bowel above the stricture will always be dilated, at times even to rupturing, ulceration of the colon being a very common consequence of the dilatation. Below the stricture there will often be found pedunculated, fleshy, or cancerous growths. These points are well seen in Fig. 331.

Fig. 331.



Stricture of Rectum. (325th, Guy's Hosp. Mus.)

It has been already pointed out that fistula, ischio-rectal, vesical, or vaginal, abscesses, and hemorrhoids are common accompaniments of stricture.

The disease, taken as a whole, is twice as common in women as in men, and I found from my own notes that 32 out of 48 consecutive cases were of the former sex. But syphilitic stricture is more common in the female, and cancerous in the male. Curling, in quoting 67 cases of cancer, gives 44 in males. In my 48 cases 20 were found in subjects under thirty, 15 of these being women, and mostly, if not all, syphilitic; 22 were in subjects over forty, half being men, the majority of these being probably cancerous.

The approach of the disease is very insidious, whatever may be its origin or nature, and the symptoms are generally such as have been given under the heading of "Cancerous Ulceration of the Bowel."

Constipation is the one early symptom, and it is not till some ulceration has commenced, either at the stricture or above it, that others appear. Of these the most common are *diarrhœa* with lumpy stools containing blood, pus, or mucus; *straining* at stool and a *sensation of burning* in the part afterward; at last a complete stoppage, abdominal distension, and dyspeptic symptoms.

An examination with the finger carefully introduced into the rectum will, as a rule, at once reveal the true nature of the case; for about two inches up the bowel the narrowing will usually be felt, with or without ulceration, or the infiltration of the part with new tissue. Sometimes the stricture is beyond the reach of the finger, and then, probably, by pressure upon the abdomen above the pelvis with the free hand or by the introduction of the hand into the rectum, the disease may be felt.

When the stricture is *annular*, it is probably cicatricial or fibrous, possibly cancerous.

When *epithelial* or positively cancerous, it will be infiltrated with a nodular, irregular mass of new tissue, which may be breaking down and ulcerating; and occasionally the mass can be felt externally at the brim of the pelvis, over the left iliac fossa.

When *syphilitic*, the ulceration will probably extend upward from the anus, and such anal integumental outgrowths as have been already mentioned will exist.

In ordinary cases of cancerous stricture there is an inch of healthy rectum between the stricture and the anus, though in exceptional instances and where disease is extensive the anus is involved.

In advanced cases the anus will appear patulous, and on separating the buttocks a red, a brickdust-colored, feculent discharge may run out; wind will also pass without effort.

To the flat, tape-like, or figured feces which some authors regard as being characteristic of this disease I concur with Curling in not ascribing much importance, since such a condition of motion is not uncommon even in a state of health when the bowels are irritable; besides, many other conditions of the pelvic parts may give rise to the same thing. When a patient never passes a well-formed motion, large or small, the case looks suspicious; and when, on the other hand, a large well-formed stool is occasionally seen, the probabilities of a stricture existing are very slight.

The examination of a diseased rectum with a tube, flexible or otherwise, with or without injection, requires the greatest care and gentleness, as the gut is easily perforated or ruptured; moreover, the surgeon may be misled to suspect obstruction where none exists by the end of the instrument striking against the sacrum or being caught in a fold of mucous membrane.

It must also be remembered, in examining a rectum for a supposed stricture, that its calibre may be more or less completely encroached upon by pelvic tumors, uterine, ovarian, prostatic, hydatid, or bony. Some few years ago I had a case with Dr. De'Ath of Buckingham in which a hydatid tumor caused complete obstruction to the rectum as well as to the bladder, and, although the latter organ was emptied on the evacuation of the hydatid contents, the patient died unrelieved from an enormously over-distended

and ruptured colon (*Trans. Path Society*, 1886). In April, 1870, I saw, with Mr. Phillips of Leinster Square, a most interesting case of complete obstruction of the bowels in a lady æt. 46, caused by the presence of a large, loose, cancerous growth hanging from the peritoneum into the pelvis, covering in the promontory of the sacrum. The tumor had been regarded by an eminent physician-accoucheur as uterine. Colotomy was performed with great relief, but death took place on the third day, from collapse caused by a sudden rupture of the tumor and escape of its softened contents into the peritoneal cavity. In March, 1875, I also opened the descending colon of a boy æt. 18 for complete obstruction of the rectum from a cancerous tumor that filled the pelvis and the abdomen as high as the umbilicus. The boy survived the operation two months, dying from other causes than obstruction.

Treatment.—It is so rare for a surgeon to be consulted about a stricture of the rectum till either the ulcerative stage has set in or almost complete obstruction has taken place that he has few opportunities of testing the value of dilatation of the stricture, since this practice is clearly useless, if not injurious, under these circumstances. In cicatricial or inflammatory strictures, however, it is the only form of practice upon which reliance can be placed.

Dilatation should be effected by mechanical means, but applied with caution: forcible dilatation is inadmissible. Many instruments have been invented for the purpose, but the elastic-gum bougie is the favorite. I have, however, known so much harm to follow its use that I have abandoned it and prefer the sponge-tent, by which a stricture can be dilated in a painless and less dangerous way. When it does not produce any irritation, a second and larger may be passed in two days; but when irritation is set up, the repetition of the operation should be postponed till it has subsided. By these means a simple stricture may be checked in its progress, and even dilated, though rarely cured. This practice may, however, prolong life for years. Mr. Curling gives a case in which he believes he cured an annular stricture in a lady æt. 24 by *incisions* and dilatation. I can record a case which occurred in a lady æt. 30 who some years before had had what she called dysentery. When I saw her, the rectum, about one inch from the anus, was narrowed by a diaphragmatic stricture which would only admit a probe. I incised this in three directions and kept it dilated with bougies. Three years later, when she died, no evidence of stricture could be made out. Another case in which for two years a lady has been in complete comfort after the operation has come under my care.

M. Verneuil, in the *Gazette Médicale de Paris* for January, 1873, has advocated the operation of rectotomy for the cure of stricture. This operation consists in an incision by means of a blunt-pointed bistoury introduced flatwise through the stricture, guided by the index finger of the left hand, and the division of the entire thickness of the strictured bowel downward and in the median dorsal line, through the anus and the sphincter, the free division of this muscle evidently playing as important a part in giving relief as the division of the stricture. Drs. C. Lente (*American Journ. of Med. Sciences*, July, 1873) and C. B. Kelsey of New York (*New York Med. Journ.*, March, 1880) have also advocated a like practice, at the same time adopting an anterior as well as posterior incision in non-malignant strictures. Dr. Kelsey's paper shows that where the disease is quite low down and within easy reach of the finger this operation gives almost as much relief as colotomy.

This dilatation, however, is only a means to an end; and that end is to secure an opening for the passage of the intestinal contents. Enemata are valuable aids to effect this purpose, the daily washing out of the bowel with gruel and oil or the daily use of mist. olei with manna, confection of senna with sulphur, or any other gentle laxative that the patient by experience has found to suit, giving great relief. Cod-liver oil in full doses often acts as a laxative as well as a tonic. Care, too, should be observed in the introduction of the tube; for in a cancerous bowel perforation is very liable to occur, and even in a healthy one this accident has taken place. The Guy's Museum contains a prep. (1877^{60}) in which the colon was perforated by a bougie thirteen inches from the anus for an imaginary stricture, and a second (1877^{80}) in which an O'Beirne's tube perforated the rectum five inches from the anus in an attempt to pass it up the healthy bowel to give relief in a case of obstruction after the reduction of a hernia.

How far it is safe to allow a patient to pass a bougie for himself or herself is another question. I am disposed to think it is unwise to allow it when the bougie is solid, having seen great irritation, and consequently harm, follow the practice, and in several cases deep-seated suppuration. Curling has given a case where the patient caused his own death by perforating the bowel half an inch in extent above the stricture. I have con-

sequently been in the habit of instructing my patients to use tallow candles as bougies, and have been satisfied with the practice.

There comes a time, however, when this treatment by dilatation ceases to be beneficial or when it is associated with much distress, as when the stricture has closed or ulcerated. Under these circumstances the question of *excision* of this disease or of the operation of colotomy may be considered. The former operation may be discussed later on. The latter gives comfort to a degree that sometimes astonishes and always gratifies; it prolongs life and adds materially to its comfort, and little more than this can be said of most operations; moreover, it is not found to be practically associated with such inconvenience as surgeons of old have theoretically attributed to it. But it should not be postponed till the powers of life have become so exhausted as to render poor the chances of recovery from the operation, or till the cæcum or large intestine has become so distended as to be much damaged or inflamed. It should be undertaken as soon as it is clear that the disease has passed beyond the reach of local treatment and the general powers of the patient are *beginning* to fail, or as soon as the local distress finds no relief from palliative measures and a downward course is evidently approaching. The difficulties of colotomy are not great, nor are its dangers numerous; when *unsuccessful*, it has often been made so by delay in its performance, from the want of power in the patient, or from the secondary effects of the disease on the abdominal viscera. When *most successful*, it gives immediate relief to most of the symptoms and makes life worth retaining; when *least* so, it lessens pain and renders endurable what remains of life. The operation is now established, and creditably so to surgical art, although it must be admitted that in the general way it is apt to be postponed until too late a period to demonstrate its full value.

Excision of the Lower End of the Rectum.

This operation has but recently received attention in this country as a means of cure for cancerous and other strictures of the rectum, although practised abroad by Lisfranc and others fifty years ago. It has, however, been performed by Billroth, by Dr. Levis of Pennsylvania, and by other surgeons. Billroth reports that he lost 19 out of 45 cases of this operation, and that the majority of his cases were unsatisfactory. Cripps's statistics are more satisfactory; he records also (Jacksonian prize essay 1877) that in 23 cases defecation was subsequently normal, in 6 that feces could be retained when not too fluid, and in 7 that there was incontinence. With these facts, it is clear that the operation for the removal of cancerous or other disease of the rectum by excision is a justifiable, and possibly a beneficial, measure, and that it should be undertaken when the disease is local and can be so defined and isolated as to come within the reach of the surgeon's skill.

It is clearly inapplicable when the disease has extended high up and the parts around the rectum are infiltrated with cancerous disease. I quite accord with this view, and have acted upon it in four cases, all females, with good success. All survived the operation—one for two years, when a return took place, and the patient died from visceral cancer; one lived fourteen months, and two are now alive, twelve and thirteen months after the operation, and in comparative comfort.

It would seem that about two and a half to three inches of rectum may be removed with safety, and that when the bladder is fairly distended and traction is made upon the rectum the peritoneal pouch is less likely to be drawn down with it than when the bladder is empty. I have satisfied myself upon these points by experiments upon the cadaver.

Operation.—After a metallic bougie has been introduced into the bladder to serve as a guide to the position of the urethra and to steady it, an incision is to be made from the base of the scrotum to the coccyx, encircling both sides of the anal aperture. The hand of the operator may then be introduced behind the bowel into the hollow of the sacrum, in order to tear the rectum loose from its posterior attachments. By means of the finger and a pair of scissors the adhesions all around the rectum where, on account of the disease, it may be firmly attached to the prostate gland and neck of the bladder, should be broken up. The cancerous gut should next be carefully dissected from these parts, exposing to view the prostate and the lower part of the bladder; all bleeding vessels should be carefully ligatured or torsed as soon as divided, and sutures passed through the rectum, above the proposed line of incision. These should not, however, be fastened, but left in position, to give perfect control over the parts. When the rectum, including the cancerous portion, has been thus carefully and thoroughly isolated, it should be drawn down and separated by means of scissors; there is no advantage to be gained by stitching the gut to the surrounding integuments. After the operation a good drainage-tube should be

introduced well into the posterior part of the sacral cavity, and sutures employed to bring the integuments together. The wound should be kept clean by daily irrigation.

Atony of the Colon and Dilatation of the Rectum.

These conditions are not unfrequently met with in practice. In old people the colon, for want of power, often becomes enormously distended with feculent matter from gradual accumulation, and this condition frequently causes death. In some cases it gives rise to the idea of stricture of the rectum, and every surgeon must have been called to cases in which impacted feces in the rectum and colon, associated with the discharge of small, loose, offensive motions, mixed with mucus, and sometimes with blood, have misled the attendant. Some years ago I was asked to see a lady over seventy who had been bedridden for six months and was supposed to be dying from constipation and stricture of the rectum, nothing but small, lumpy, and loose motions having passed. No disease whatever existed beyond the impacted rectum and distended colon from atony of the bowel from old age. The masses were mechanically removed by means of the lithotomy scoop and enemata of oil, etc., and she lived four years afterward and died simply of old age.

Treatment.—In this form of constipation the value of nux vomica is well seen, a pill composed of half a grain of the extract with half a grain of belladonna, twice a week or oftener, giving tone to the intestine and acting as a purge.

In women especially who have been in the habit of neglecting their bowels and allowing the rectum to be a closed receptacle for feculent matter the cavity not only becomes much distended, but seems to lose the power of contracting and expelling its contents. I had some years ago, at Guy's, a case illustrating these points. The rectum, on examination, feeling like a loose bag, large enough to admit a fist, was always full, having evidently lost all power of expulsion. The woman in young life had neglected herself, and in middle age could not overcome the effects of such neglect. By daily enemata of cold water to wash out the bowel, and the subsequent injection of an astringent liquid such as the decoction of bark and alum, with the daily use of a pill containing half a grain of extract of nux vomica mixed with gentian, a complete recovery took place.

The Administration of Food and Medicine by the Rectum.

Physiologists have long known that water and certain forms of food and medicines are absorbed by the rectum, and physicians have acted upon this knowledge, though possibly the physiological fact has not been utilized so fully as it deserves.

It has, however, such an important bearing for good upon surgical practice that it would be well to regard the rectum as a second stomach, and in certain cases to use the one for nutritive or medicinal purposes as a substitute or accessory for the other. I have for years acted upon this principle, and have every reason to be satisfied with the result. Indeed, in any case of disease or injury in which nutriment is essential and the stomach refuses to receive or retain food, I have never hesitated to resort to the nutrient enema.

I do so also in cases of abdominal injury or disease in which it is *inexpedient* to give the stomach or small intestines work to do. In aged patients, after injury or operation, when, from shock, the stomach seems incapable of doing its duty, as well as in all cases of persistent vomiting, whether after the use of anæsthetics or otherwise, it gives time for the stomach to regain its tone. The use of the nutrient enema for a few hours often tides over a slight, and for days over a great, difficulty, as without doubt it supplies food to the body almost as well as the usual meal, and does so under circumstances in which the latter cannot or ought not to be administered. In a case I had with Dr. Parsons Smith of Addiscombe life was entirely maintained for fifteen weeks by its use, and I could adduce others in which its beneficial influence was most marked. Dr. Flint of New York has published one case in which life was sustained for fifteen months by this method, and he adds that during five years the patient had depended almost entirely upon it. In cases of unconsciousness from anæsthetics or otherwise this practice should be followed in preference to any other, as it seems more than probable that under these circumstances any fluid which it is attempted to pour into the mouth passes into the lungs rather than into the œsophagus, and consequently hastens death.

Directions for Use.

The bowels should be emptied by a simple enema before the nutrient one is introduced.

The nutrient enema should be used every four or six hours, and should not consist of more than four or six ounces.

The material should be tepid and introduced *slowly*, as the rectum repudiates any sudden distension.

After its administration a napkin should be pressed against the anus until the disposition to expel it has passed away.

When the expulsive tendency is great, five or ten drops of the tincture of opium may be added to the enema; indeed, under all circumstances, it is of advantage.

At times the enema is retained better when introduced some six inches into the rectum than when only just within the sphincters.

When injections are badly tolerated at first, they may at times be well retained if they are persisted in.

The best materials for these enemata are milk, eggs, meat juices, with pancreas or pancreatic emulsion. These may be employed at different times, since it is a mistake to keep too long to one kind.

Milk and eggs, alternating with one of meat juice and pancreas, seems to be preferable.

Darby's peptonized fluid meat is very good.

As a meat emulsion Kaufmann's mixture is excellent, composed of a pound of minced or scraped beef, a third of a pound of fresh pancreas, and half a pint of cold water, the whole allowed to macerate for three-quarters of an hour, gradually raised to the boiling point, and boiled for two minutes. The mixture will then have been reduced to the consistence of a thick soup.

When this mixture is not at hand, good beef tea or mutton broth may be employed, to which Liebig's extract of meat may be added.

In making beef tea or broth long boiling does no good. A pound of finely-minced meat macerated in half a pint of cold water for three or four hours will give an excellent mixture; and if the whole is well shaken for half an hour, nearly the same result is obtained.

On several occasions I have found Slinger's (of York) nutrient suppositories of great use.

Rectal medication in its way is as valuable as alimentation, more particularly when morphia, opium, or mercury is prescribed, the former drug, administered after an operation before the influence of the anæsthetic has passed off, doing more to calm the patient and give rest than any other method, more particularly in cases of abdominal surgery.

The mercurial suppository employed twice a day acts on syphilitic patients in such a quiet and beneficial way as to lead me to look upon it as the best method of bringing any one under the influence of the drug.

SURGERY OF THE RESPIRATORY SYSTEM.

CHAPTER XVII.

SURGICAL AFFECTIONS OF THE NOSE.

Congenital and other Defects of the Nose.

The nose may be congenitally absent or fissured, as illustrated in Fig. 52; the nostrils may likewise be congenitally or otherwise occluded from cicatricial contraction after ulceration or small-pox; and for these defects surgery may be successfully called into requisition either to establish an orifice or to prevent its contraction.

Wounds.

Incised and lacerated wounds of the nose generally progress well, on account of the freedom of its vascular supply. The edges of any wound should consequently be brought carefully together and fixed with sutures, even if the part be nearly or wholly separated from the body. For this purpose very fine silk ought to be used and great care exercised in the accurate adjustment of the parts, a suture being passed through the cartilages when they have been divided. In the case illustrated in Fig. 332, where the nose was nearly cut off, the edges of the wound were adjusted, and a good recovery followed.

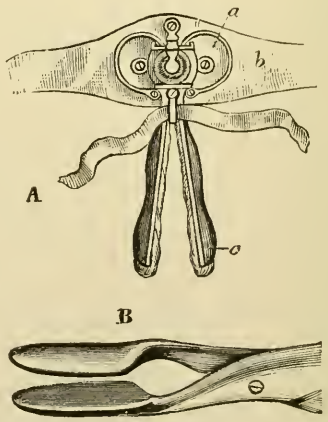
Fracture of the Nose.

This accident is not uncommon and may be simple or compound. It may likewise be followed by little or great deformity, the amount depending much upon the care and skill

Fig. 332.

Drawing illustrating the Repair after an Incised Wound of the Nose.

Fig. 333.



Forceps and Nose Truss for Treatment of Deformed Nose.

with which the broken bones have been readjusted. When displacement has taken place, the surgeon must restore the misplaced bones by external manipulation, aided by pressure applied from within the nasal cavity by means of the blades of the ordinary dressing forceps or a steel probe. When the parts have been restored to their natural position, or as nearly so as is possible, care must be observed that no external pressure is employed by which they can be displaced. Plugging of the nostrils is useless.

When little or no displacement exists, nothing better is required than the application of cold-water dressing, or perhaps ice, for the first few hours, as these bones rapidly reunite.

Dr. L. D. Mason of Brooklyn, United States, has suggested the use of a wire suture passed transversely through the nose to keep depressed fractures in position (*Annals of Anat. and Surg. Society*, 1880).

When the force has been severe and direct upon the nose, fracture of the skull may complicate the case—fracture either of the ethmoid bone forming the floor of the base of the skull, as has been illustrated in the chapter on injuries of the skull (Fig. 75), or fracture of the frontal bone. This latter form may be generally recognized by swelling and crepitation of emphysema about the forehead or the crepitus of the fracture with displacement, etc. Cases of fracture of the frontal sinus require no special treatment, and generally do well.

In children the cartilage of the nose may be displaced from the nasal bones in consequence of an injury, and, unless replaced, permanent deformity and obstruction will ensue. The surgeon, consequently, when this accident takes place, should do his best to restore the misplaced parts and to keep them in apposition, although some difficulty is often experienced in its accomplishment.

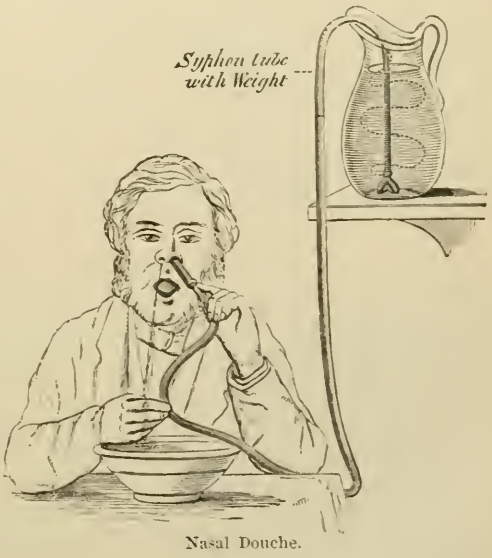
With the view of preventing or correcting deformity, Mr. W. Adams has suggested that the broken or bent septum should be straightened by strong plate-bladed forceps (Fig. 333, B) and the broken nasal bones raised, these parts subsequently being maintained in position by an ivory clamp, and the side of the nose pressed into place by a nose truss (Fig. 333, A) connected with a forehead plate (*a*) and band (*b*). The plates (*c*) are shaped according to the outline of the nose and are made to diverge by rotating a central controlling screw, the pressure of the plates being regulated by two circular springs. The ivory clamp must be worn day and night for three or four days after the deformity has been corrected, and the nose truss for some months during the day.

Epistaxis.

Bleeding from the nose is an occurrence of considerable frequency, and when not too free or lasting rarely requires surgical interference. It may be the result of an injury—*traumatic*—or associated with some cancerous affection or fibrous growth from the base of the skull or other local cause, or it may be the direct consequence of some fulness of the vessels of the head or heart disease. It is found also as a kind of *passive* exudation in anæmic and cachectic subjects after purpura or from hepatic disease, and also as supplementary to the catamenia.

Treatment.—With a view to successful treatment, the cause of the bleeding must be ascertained. When traumatic, it usually stops without aid. When due to plethora of the vessels from any cause, it is often salutary, and should be checked only when too copious or lasting. When of a passive nature, it is serious, since anæmic feeble subjects cannot bear loss of blood, and the loss tends to aggravate its cause. In one case, therefore, saline purgatives may be of value; in another, iron in full doses, or gallic acid in gr. v or gr. x doses. As to its treatment no definite rules can be laid down, it being a common accompaniment of so many different conditions, local and general.

Fig. 334.



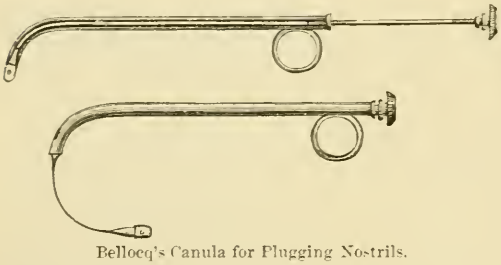
Nasal Douche.

When, however, life is threatened by its severity, real or comparative, the surgeon is bound to interfere. The head should be kept raised and cold applied by means of ice to the nose and frontal sinuses. A steady stream of some cool saline liquid (a teaspoonful of carbonate of soda and common salt to a pint of water being as good as any) passed through the nostril is a very effectual mode of treatment. For this purpose the double-action india-rubber enema apparatus with a nose-piece to introduce into the nostril may be employed, or Dr.

Rasch's vaginal syphon douche, applied as in Fig. 334, the patient breathing at the time through the mouth, which should be kept wide open. Prof. Weber of Halle having discovered years ago that while the patient is breathing through the mouth the soft palate completely closes the posterior nares and does not permit any fluid to pass into the pharynx. The popular methods of placing the patient in the erect posture and raising both arms above the head may likewise be tried, as they are unquestionably good. If these measures fail, the nostril or nostrils must be plugged.

Plugging Nose.—To do this effectually some skill is necessary; to do it otherwise is useless, if not injurious. To plug from the anterior nares alone is to trifle with the hemorrhage and merely to mask the escape of blood as well as to direct it down the pharynx, under which circumstances severe loss of blood may take place without knowledge. To perform the operation of plugging effectually, a plug of lint, cotton-wool, a sponge tent, or compressed sponge, an inch and a quarter long and an inch wide, should be prepared and fastened in the middle by a double piece of strong silk or whipcord, an end about six inches long being left on one side, and two ends or a loop a foot long on the other. With Bellocq's canula (Fig. 335), a long-eyed probe, or an elastic catheter a loop of the same material should be passed into the nose along its floor through the posterior nares into the pharynx, and caught either by the fingers or forceps. This end should then be fastened to the long ends on the plug and the instrument withdrawn through the nostril. The plug, having been well oiled, is then to be drawn into the mouth by applying traction upon the ligatures protruding from the nostril, tilted with the finger behind and above the soft palate, and carefully adjusted or wedged into the posterior nares, by which means the escape of blood into the pharynx will be prevented. The two cords hanging from the anterior nares are then to be separated and the nasal cavity filled with compressed sponge, lint, or cotton-wool, which should be introduced between them, the whole mass being made secure by tying the two cords across the plug that has been introduced in front and fastening them in a bow, to allow of unfastening. When any styptic is deemed necessary, the sponge, cotton-wool, or lint introduced into the anterior nares may be saturated with the solution of the perchloride of iron, tannin, matico, or a concentrated solution of alum. By this means the possibility of any escape of blood from either opening of the nose can be effectually prevented and the most dangerous epistaxis absolutely controlled. To remove the apparatus, the knot at the anterior nares should be undone and the anterior plug taken out, the posterior being readily drawn from its position by means of the short end attached to it in the pharynx, which may be left hanging down the patient's throat. The plug should not be left in more than three or four days, but may be reintroduced if necessary, the surgeon, in doing so, taking care to preserve *in sitû* the two pieces of cord that have been passed along the floor of the nose. The inflating nasal india-rubber plug of Mr. H. C. Howard is likewise good for plugging purposes. It can readily be inflated when in position, and as readily removed (*Brit. Med. Journ.*, 1881, p. 896).

Fig. 335.



Bellocq's Canula for Plugging Nostrils.

Lipoma—or, more correctly, Hypertrophy

of the nose—is a readily recognizable affection and is a disease of the skin and subcutaneous tissue (not of the cartilages), in which the follicles may or may not participate. It is confined to the apex and the alæ of the organ. The enlargement is sometimes general; at others the swellings are pendulous, lobulated, and loose. The capillaries of the part are sometimes congested, giving the growth a purplish hue. As a rule, it is painless and causes only mechanical annoyance It interferes at times with vision and the functions of the nose, and, moreover, wounds vanity.

Treatment.—Nothing but the removal of the growth can be suggested, which can be done without danger and with no great difficulty. The redundant mass is to be dissected off, care being observed not to encroach upon the nostril. This is best done by introducing the little finger or a spatula into the nostril and shaving the redundant mass off the cartilage with a scalpel. Any bleeding that may take place can usually be checked

by cold, stypties, or torsion; the wound that is left should be allowed to granulate. The surgeon should be careful not to take away too much or to go too deep, but to leave some covering to the cartilages. The disease rarely returns. The late Mr. Hey of Leeds was the first to perform the operation described.

Lupus.

This affection is more common on the nose than in any other part of the body and is often very destructive—so much so, indeed, as to destroy the whole organ. It is, however, more amenable to treatment than is usually supposed. Too often it is described as a strumous, and therefore constitutional, affection, and regarded as incurable. It would be well, however, if surgeons would practically regard it more as a local disease.

Treatment.—The best local treatment is its entire destruction, which may be effected by scraping away the diseased tissue with a blunt knife or the handle of a scalpel, followed by the application of carbolic acid on lint to the exposed surface, by excision or the free application of the galvano- or thermo-cautery. One of the worst cases of lupus of the nose that I have seen was that illustrated in Fig. 336. It had existed for years, and was cured in a month after one free application of the galvanic cautery, every ulcerating tubercle of unhealthy tissue being freely destroyed.

Fig. 336.

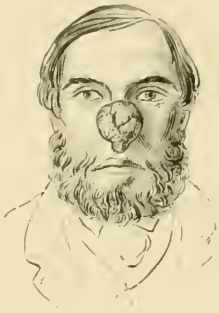


Fig. 337.

Lupus of Nose, with the Outline of a Flap for a New Nose. (From life.)

Tonic treatment also must not be neglected, while as a palliative application cod-liver oil is very beneficial. Arsenic is also highly commended by Messrs. Hunt and others, and Donovan's solution when there is any syphilitic taint.

The lupus non-exedens may be regarded as an early stage of the lupus exedens; both have a papular origin and become tubercular, the tubercles ulcerating at a later stage.

Epithelial Cancer and Rodent Cancer

may attack the nose, the former usually appearing at first as a warty growth, which subsequently ulcerates; the latter as a firm, uncolored, solitary nodule, which excoriates, then scales and bleeds, and finally ulcerates, deepening and extending the scabbed excoriation. In the epithelial cancer the margin of the sole is more irregular and thicker than in the rodent ulcer, although, until the lymph glands are affected, it is somewhat difficult to distinguish between the two. Indeed, the epithelial cancer may be for long undistinguishable from the rodent cancer. The treatment of both, however, consists in the total destruction of the ulcerating surface and its edges by cautery, escharotics, or the knife. I have treated many of the epithelial forms by means of the galvanic cautery with gratifying success. The disease, like other cancers, is, however, liable to return.

Rhinoscopy.

The examination of the nasal cavity may be made through the nostrils by means of a speculum, and for the purpose reflected sunlight is the best, or, this failing, reflected artificial light must be employed. The posterior nares can be examined by means of a mirror introduced behind the soft palate, after the same fashion as in laryngoscopy, the parts being reflected from the mirror, which is illuminated by sun- or artificial light. The best aid may also be obtained by means of the finger introduced through the mouth behind the soft palate. Czermak speaks highly of the value of a small mirror introduced through the nostril, which should be well illuminated. I have, however, found all the help I wanted in digital examination and posterior rhinoscopy, taking care to draw forward with great gentleness the soft palate by means of forceps. This method of examination is, however, at times difficult.

Diseases of the Nostrils causing Obstruction.

These are very common, and for such the surgeon is often consulted. In the infant such a condition may be the result of congenital syphilis, which will be indicated by the history of the case and the concomitant symptoms. The *snuffles* in infancy are very characteristic, and should always direct the practitioner to look out for some syphilitic affection. In isolated cases such a symptom may be the only one of hereditary syphilis, and by proper treatment it may be cured without any other complication making its appearance, although as a rule, if looked for, some cutaneous affection will be observed, a grain of gray powder with three or four grains of dried soda twice a day generally proving quite sufficient to cure the disease. When the mother is suckling, the child may be physicked through the mother, taking five or more grains of the iodide of potassium with quinine half an hour before suckling three times a day.

Warty growths are sometimes met with at the orifice of the nostril, causing obstruction. They are to be cured by the removal of the growths.

Foreign Bodies in the Nasal Cavity.

When a child suffers from any obstruction to the nasal cavity, and particularly when such is one-sided, the presence of a foreign body should be suspected; and the practitioner in such instances should never allow himself to be misled by the absence of a history of its introduction, since instances are not uncommon where some foreign body has been left in the nasal canal for months. A child four years of age came under my care who had suffered from all the miseries of an obstructed nasal passage for eight months from the presence of a plum-stone. Many remedies had been tried, but without effect, the foreign body being unsuspected. Its removal was rapidly followed by convalescence. Ulcerations of the mucous membrane from the inflammation excited by the foreign body may tempt the surgeon to overlook the nature of the case. He should therefore remember that such a disease as ulceration of the nose in children, except at the immediate orifice, is by no means common, and that the probabilities of its being excited by a foreign body are very great. When only one nostril is affected, the diagnosis is more sure. The removal of these bodies when firmly impacted requires some care, and the administration of an anæsthetic cannot be too highly recommended, particularly when the child is young. A firm, hook-bent probe introduced down the floor of the nose may be passed with facility behind the foreign body, or a noose of wire, twisted or not, inserted along the septum and half turned, will generally, after one or two attempts, hook out the offending body. In some cases a pair of forceps will suffice. Gingerbread and other soft materials may have to be scooped out and the nose well syringed. I have never known any good result from syringing this cavity when any solid body has become impacted, except for the sake of cleanliness. Mechanical means always succeed and are the simplest, particularly when the child is under the influence of an anæsthetic. In older children and in adult life obstruction to the nasal passage may be produced by many diseases. When the presence of a foreign body is the cause, a true history of the case will generally be given, and thus the surgeon is more likely to arrive at a just conclusion as to the character of the disease.

Nasal Calculi, or Rhinolithes.

Such cases have been recorded; I have seen but one instance, and that proved to be due to the introduction of a foreign body. It occurred in the practice of Mr. B. Duke of Clapham. On examination by Dr. Stevenson the calculus was found to consist of 75 per cent. of earthy carbonates and phosphates, and 25 per cent. of organic matter with cotton-wool. They may be small or so large as to obstruct the nostril. Obstruction and more or less pain are said to be the chief symptoms, and occasionally a copious discharge of mucus or pus. The calculus can be detected on examination; and when found, it should be removed by douche, snare, or forceps. Cases are on record in which the concretion was crushed before removal.

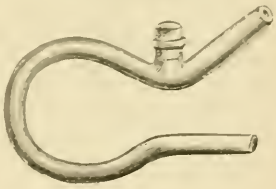
Polypus Nasi.

This is a common affection, and may be found in one or both nostrils of the old or young. It may be of a simple mucous or fibrous structure or it may be of a malignant nature. The mucous are by far the more common forms, and are not difficult to recog-

nize; they, as a rule, spring from the middle turbinated bone and from its posterior portion, though they may grow from other parts. I have removed only one from the septum. They are seldom recognized in an early condition, since they cause no pain and but little inconvenience. A slight excess of discharge is the earliest symptom, and this is generally regarded as being the result of "cold;" but when this secretion is examined, it will be observed to be more serous than is found to exist in an ordinary coryza. In exceptional cases the serous flow may be very free. Sir J. Paget has recorded (*Clin. Soc. Trans.*, vol. xii.) a case in which this symptom existed and where after death fine polypoid growths were found in the antrum. The discharge, continuing, may at last cause some anxiety to the patient; and if the surgeon be consulted, a careful examination with a speculum should be instituted, when a polypus, or rather a fringe of polypi, will often be observed on the margin of the middle turbinated bone.

Treatment.—When the disease has been made out, removal of the growth is the only effectual treatment. Tonics and local astringents may for a time retard its growth, but rarely effect a cure. The use of tannin as a snuff has been very successful in my hands in causing the sloughing off of even the largest polypi (*Lancet*, February, 1867), but the remedy is uncertain; it is, however, always of value in destroying the smaller, and thus in checking the progress of the disease. Of late years I have employed a spray composed of equal parts of alcohol and a ten-grain solution of boracic acid to the ounce of water, the alcohol withering the small growths.

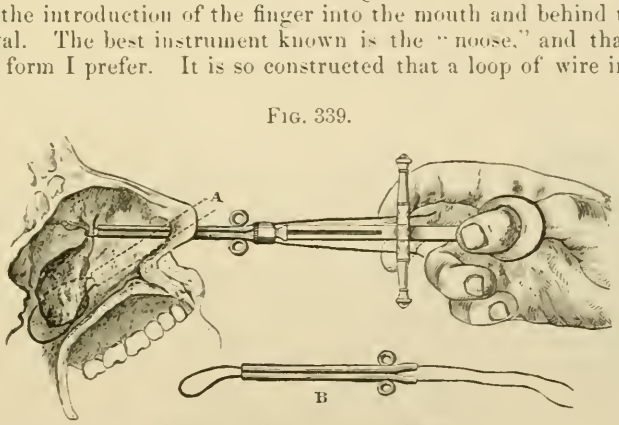
Fig. 338.



I have had several instruments made to apply the tannin, but the bent glass tube is as good as any. It is modified from one made by a patient for his own use, and answers well. The tannin is put into the small receptacle in the upper half, that end of the tube being inserted into the nostril, and the other into the mouth, and the patient then blows tannin into his nostril.

The removal of the softer kinds of polypi should always be by abruption. Some surgeons employ a long pair of narrow well-made forceps, which fix the pedicle, and then by a slight twist and some force the removal of the growth is effected. When the polypus hangs far back, the introduction of the finger into the mouth and behind the fauces facilitates its removal. The best instrument known is the "noose," and that illustrated in Fig. 339 is the form I prefer. It is so constructed that a loop of wire introduced along

Fig. 339.



Removal of Nasal Polypus by Noose.

the septum and half turned can be made to pass over the polypus and encircle its pedunclc. The loop is then drawn home, the growth strangled at its neck and abrupted. By these means the polypus is removed as a whole and bleeding is prevented; consequently, by the use of this instrument, the nose can generally be cleared at one operation. In some cases I have cured the disease by cutting off with a long pair of scissors the turbinated bone from which these polypi grow. A few days after the removal of the polypi by the snare, tannin as a snuff or the alcohol and boracic acid lotion used as a spray may be employed.

In severe cases in which this treatment has been employed with but poor success, Rouge's operation, as suggested by him for the treatment of certain cases of ozæna in 1873, may be performed, the operation consisting in the elevation of the upper lip and soft parts of the nose from their osseous attachments by means of an incision made beneath the lip through the mucous membrane where it is reflected from the lip into the

gums, the lip and nasal cartilages by these means being so freed from their attachments as to allow the surgeon to lift them up as a whole toward the forehead, and thus reaching the nasal cavity for purposes of exploration or operation. To give more room, the septum nasi may require to be separated from its base. After the operation the parts readily fall into position, and should be kept there by strapping. No deformity or visible scar follows the operation.

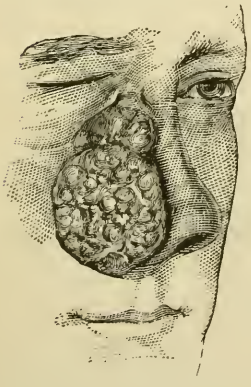
The mucous form of polypus seems to be more common in men than in women and is a disease of young adult life. I have known it, however, to appear in a man aged seventy-five.

The firmer and fibrous forms of polypi are by no means so common as the mucous, and seldom spring from the turbinated bones. They grow more frequently from the upper and posterior portion of the nasal cavity, from the top of the pharynx and the posterior nares, and have a periosteal origin. They do not make their appearance so early in life as the mucous, are far more serious in their nature, and more difficult to treat, on account of their position; and when removed, they rarely return.

TREATMENT.—The best mode of treatment is to ligature them through the nose by means of a loop of whipcord or wire passed through the nostril into the pharynx and slipped over the growth. When this operation cannot be performed, the nostril may be laid open, to give room for manipulation, or it may be necessary to remove the nasal process of the superior maxillary bone or displace the body of, but not remove, the upper jaw itself to reach the tumor. In 1865 I removed a large tumor of this kind which completely obstructed the posterior nares of a boy æt. 14 by the ligature introduced through the nostril (*Path. Trans.*, vol. xviii.), and in 1868, I removed a second from a lad æt. 18 in the same way. In 1872, in another case, I took away a portion of the upper jaw to get at a tumor of the spheno-maxillary fossa which filled up the nostril from behind. In 1883 I removed by evulsion from a man who was dying from bleeding a large growth from behind the palate and posterior nares, but with a fatal result, the growth having sprung from the base of the skull and invaded the cranium. Some of these polypi grow from the antrum and press inward. The surgeon should bear this fact in mind in examining a case, as it may materially affect his treatment.

Cancerous tumors of the nose are found in practice, although not frequently. They may attack the body of the organ, as seen in Fig. 340, or grow from within and press forward or backward, filling in the anterior or posterior nares, when they are difficult to diagnose. They are perhaps more common in the old than in the young, although two cases have passed under my care in patients under thirty. They are generally associated with bleeding, from either the nose or the pharynx. When they grow from within, their removal, when possible, is an expedient practice, if only to give relief; and this can be done much in the same way as in the other varieties of polypi.

FIG. 340.



Cancer of Nose.

Conditions simulating Polypus.—The conditions of the nasal cavity which are not infrequently mistaken for polypus are numerous. Many such have passed under my notice, the patients applying for the removal of such a growth, when in reality no growth existed.

Malformation of the septum nasi is one of the most common deformities of the nose. In it the septum projects into either the right or the left nostril, causing more or less obstruction to respiration and leading a superficial observer to believe in the presence of some new growth. This deformity may sometimes be the result of an injury; and when so, there is generally some lateral twist of the nose itself. The knowledge of the existence of such a condition is quite sufficient to prevent any careful surgeon falling into this error. For the relief of this deformity an attempt may be made by Adams's forceps to loosen the septum and to fix it in a better position, or comfort may be given by admitting air through a perforation of the septum made by cutting forceps.

A chronic inflammation and thickening of the mucous lining of the nose is another condition which may be, and frequently is, mistaken for polypus. In it the patient complains of difficulty in respiration and feels that there is something in the nose which mechanically impedes that function. On examining the cavity a smooth, projecting, and firm outgrowth will be observed on its outer wall, which may be regarded

as a polypus, but which is really only the lower turbinated bone covered by a thickened œdematous or inflamed mucous membrane. In a case such as this, if a little care be taken in sifting its history, it will probably be found that an obstruction to the respiration will be the only symptom of importance; there will be no serous discharge, such as is so copious in cases of polypi, although there may be a discharge of tenacious mucus; yet this is not common, since the secreting function of the mucous membrane in these cases will generally be found diminished and a great dryness present, accompanied by a loss of the sense of smell.

Treatment.—The best treatment in such examples is the constitutional in the form of tonics, using that which appears to be most suited to the general wants of the patient's system. Some slight stimulating lotion, such as the sulphate or chloride of zinc, or nitrate of silver of the strength of two grains to the ounce, may at times be required, but constitutional means alone are generally sufficient. Removal of the turbinated bone for this affection has been advocated and performed by some surgeons. I have adopted the practice in some obstinate cases with marked success.

It is worthy of observation that this disease is at times confined to the mucous membrane over the lower turbinated bone, and for reasons which I am unable to explain.

The septum may likewise be the seat of inflammation, either acute or chronic; and, as a result, great swelling of the soft parts covering it in will be present, giving rise to obstruction. When pus exists, an early opening is advantageous. In some cases a perforating ulcer may appear; in others, exfoliation of the cartilage. I have removed from a boy a *cartilaginous outgrowth* from the septum which obstructed the nostril, which had a base the size of a sixpence.

Ozæna.

This term is applied to a large and important class of cases where an offensive discharge, or rather smell, is the common symptom, which is due to many different morbid conditions.

It has been said that this offensive smell is the result of some morbid secretion of the part, but my own experience has not furnished me with any information tending to confirm such an idea, and I believe that the fetor is generally, if not always, the result of the decomposition of retained mucus. At one time it may be associated with inflammation or ulceration of the mucous membrane, and at another with some diseased bone the result of syphilis or otherwise. Under all circumstances the disease is an insidious one, and many months have usually elapsed before it comes under the notice of the surgeon or medical adviser.

Symptoms.—The patient at first believes the symptoms to depend upon an ordinary catarrh, the discharge from the nose being thick, but not offensive, and the sense of smell more or less impaired. If these symptoms continue, the health of the sufferer often declines; and the physician is consulted on account of want of power, the local symptoms assuming a secondary importance. If the nose be examined at this time, as it should be, with a speculum, to obtain a good view of the whole, the only visible morbid condition may be either intense congestion of the mucous membrane, which will not be much, if at all, thickened, or some ulcer, this congestion of the mucous membrane being associated with excess of secretion and the ulcer with a variable discharge. When dead bone exists, a probe will detect it.

Treatment.—In the majority of cases the only correct and satisfactory treatment is the constitutional. When the general condition of the body is improved, the local disease will disappear. To this end the hygienic conditions by which the patient is surrounded should be considered. If tonics, as quinine or iron, are indicated, they should be administered; the secretions also should be attended to, and all external and internal causes which may prove detrimental to health removed. The *local* treatment consists in absolute cleanliness and the removal of all retained secretions; for this purpose there is nothing equal to the use of the douche (Fig. 334) with saline medicated lotions. The inhalation of steam will at times assist the removal of the secretion and relieve the state of fulness of the part of which some patients so much complain, especially if the discharges have a tendency to desiccate, adhere to the mucous lining, and, as a consequence, to putrefy, since it is this putrefaction of the retained muco-purulent secretion on which essentially depends the condition denominated *ozæna*. Medicated lotions are sometimes required, such as iodine or boracic acid lotion ten drops or grains to the ounce. Condy's fluid, carbolic acid, the sulphate or chloride of zinc, or nitrate of silver, in the strength of

about one grain to the ounce of water. The inhalation of the fumes of iodine is always useful.

When ozæna is associated with some ulceration of the passage—an ulceration that may be seen through the speculum, and, if not seen, suspected to exist when an occasional escape of a blood-stained muco-purulent secretion takes place—tonics are still called for, with cleanliness locally, topical stimulants being employed when simpler means have failed or when great indolence of the part is present.

These cases are, however, very obstinate, and much time is frequently required to bring about a cure, several months being often not long enough; but the fetor, which is the chief symptom of annoyance to the sufferer, may speedily be removed by the mechanical and local means already suggested, and so the worst feature of the disease becomes destroyed and the mental as well as the physical comfort of the patient secured.

When, however, this inflammatory action, and perhaps ulceration, is allowed to continue, a different result will ensue; the bone itself may become involved, and as a result necrosis follow. In so-called strumous subjects this condition is not infrequent. I have, however, no evidence to give that such a necrosis is always the result of the extension of the inflammation from the soft parts around the bone to the bone itself. In many cases, I believe, if not in the majority, the disease originates in the bones.

Necrosis of bone in the nose is not an unfrequent condition, and, as such, is another cause of the disease described as *ozæna*. It is found in children as well as in adult life, and may be the result of injury, extension of disease from the soft parts covering the bones, or associated with the so-called strumous diathesis or with the syphilitic poison. Occasionally it takes place without any such distinct cause, when it is described as idiopathic, it being well known that inflammation of bone may arise *per se*.

When ozæna is the result of necrosed bone, the fetor is generally of a peculiar character, such as is well known to accompany diseased bone; and under these circumstances, by careful examination with the speculum or probe, bare bone will often be detected, by which the nature of the disease becomes tolerably evident. In early life I believe that inherited syphilis is a more frequent cause of this affection than is generally suspected, and this opinion has been confirmed by the presence of other marked symptoms in some cases, such as old skin diseases, syphilitic teeth, or keratitis.

Diagnosis.—To form a correct opinion in all cases of ozæna, a careful history of the case must be obtained and well-known symptoms not overlooked; for unless an accurate knowledge of the case can be acquired, the treatment adopted must be doubtful, and consequently unsuccessful.

Treatment.—When the presence of necrosed bone has been made out as the cause of the disease called ozæna, it is tolerably evident that the patient will not recover until the fetid bone has been removed, or rather has exfoliated. To this end the preservation of perfect cleanliness by means of a douche or syringe, with or without stimulating or antiseptic lotions, may be employed, and tonics should be administered. If syphilis, either hereditary or acquired, is the apparent cause, our remedies must be modified to the general requirements of the patient. Mercurials are seldom necessary, although in children suffering from this disease, where the history and other symptoms of congenital syphilis are present, I have given them, associated with tonics, with marked benefit, and in obstinate cases in adult life such a combination may also be employed. The perchloride and green iodide have proved the best forms in my experience, and when combined with tonics, such as quinine, bark, or iron, are invaluable. I generally prescribe the perchloride with bark and the iodide in pills at bedtime, the patient taking at the same time the syrup of the iodide of iron and the iodide of potassium in some bitter infusion, such as quassia. If mercurials are not indicated or required, the combination of the iodides of iron and potassium cannot be too highly valued.

In strumous subjects, perfect local cleanliness, and perhaps stimulants, accompanied with tonics, as cod-liver oil, quinine, or iron alone or in combination, generally suffice. In exceptional cases an operation may be required for the removal of the dead bone, and where by forceps the bone cannot be taken away Rouge's operation (*vide* p. 591) may be performed.

Disease of the Frontal Sinus.

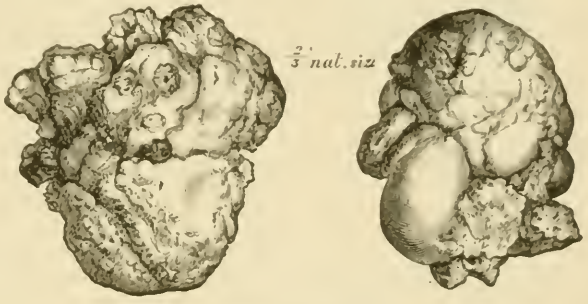
The frontal sinuses, as part of the nose, are liable to many of its diseases. Acute or chronic catarrhal inflammation is by no means uncommon, both giving rise to a dull heavy pain over the forehead, which the inhalation of the fumes of half a grain or more of opium thrown on a hot piece of metal often speedily relieves.

Acute suppuration of these sinuses is occasionally met with, and is attended with severe local and general symptoms. Under these circumstances the application of the trephine to the outer shell of bone may be required. Necrosis of the bones covering in the sinuses may exist, and the latter are also liable to fracture. New growths may likewise be found in this locality, cancerous, myeloid, or bony, *the ivory osseous growths* being more frequently found in the air-cells of the frontal bone and nasal fossæ than in any other locality. From modern investigations they appear to have a periosteal origin and soon become loose. In Hilton's well-known case the growth sloughed away. In the

Fig. 341.

Enostosis of Frontal Sinus.

Fig. 342.



Enostosis after Removal.

case of my own, from which Figs. 341 and 342 were taken, the osseous mass was evidently dying when it was removed. It had been growing in the frontal sinus of a man æt. 24 for four years, and had gradually encroached upon the orbit. I enucleated it from its bed by means of an elevator, after having taken away the layer of frontal bone that covered it in. A good recovery ensued (*Guy's Hospital Reports*, 1873–74). M. Olivier's treatise upon the subject, published in Paris in 1869, gives all the facts known about such growths.

In all tumors occupying the centre of the frontal region in children the possibility that any one may be a hernia of the brain and its membranes should be borne in mind.

Distension of the frontal sinus is an affection not sufficiently known: indeed, it has been described only by Lawson and Higgens. It shows itself as a chronic swelling or expansion of the bone near the inner angle of the orbit above the lachrymal sac, and is attended at times with pain of a dull aching character. Occasionally the affection is painless or the pain is intermittent. Sometimes with the swelling there is some watering of the eye, and in rare cases the eyeball is pushed outward. Injury is said by Lawson to be its common cause, but in the three cases I have seen it come on of itself. When injury has been the cause, it was probably a fracture, the fracture bringing about a closure of the communication between the middle meatus of the nose and frontal sinus. The swelling contains a more or less purulent tenacious fluid.

Distension of the frontal sinus, writes Higgens,[1] "has probably no early symptoms. There is at no time severe pain, nor, indeed, any until the disease has far advanced." Indeed, it is probable that the disease is not to be recognized until the orbital wall of the sinus begins to bulge or the bone has so thinned as to allow the distended sinus to appear as a soft fluctuating swelling with a raised bony and clearly-defined margin. In one of my cases this condition was very marked.

Diagnosis.—When the swelling is hard and bony, it may be mistaken for an osseous growth, such as is figured in Fig. 341. When it is soft and fluctuating, it may be regarded as an abscess connected with the lachrymal sac. When the bone has thinned and gives a crackling sensation on pressure, or when, as noted above, a soft fluctuating swelling surmounts an elevated bony ridge, its true nature is rendered probable; and when the tumor varies in size at different times of the day, the diagnosis is certain, this variation in size being, according to Higgens, "due to the fluid becoming—when the patient lies down—evenly diffused throughout the sinus, whilst it gravitates to the part after the erect position has been maintained for a few hours."

[1] *Guy's Hosp. Rep.*, vol. xxv., 1881.

Treatment.—There is but one kind which can bring about a cure, and that is the free opening of the swelling and its efficient drainage into the nose, which should be guaranteed by the introduction of rubber tube. The cavity should be washed out daily with some antiseptic. In two of my three cases a cure was effected by these means after the lapse of months. In one case the sinus through the forehead is still open.

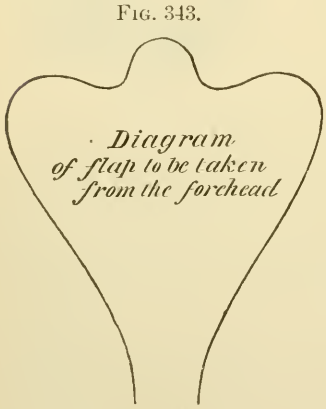
Rhinoplastic or Taliacotian Operations.

Gaspar Tagliacozzi, or Taliacotius, professor of anatomy and surgery in the University of Bologna, was the first to bring these operations into notoriety, and they have consequently been named after him. He was not, however, the originator of the operation, as he himself refers to earlier men, such as A. Paré and others, who have recommended it; but he was the first to practise it with much success, and quite deserves the fame that attended his efforts. His principal work, published in 1597 at Venice, only two years before his death, gives the histories of the cases in which he operated.

His method consisted essentially in taking a flap of skin from the arm and transplanting it to the nose, and so restoring that organ to its normal appearance where there had been any loss of substance.

Modern surgeons, instead of following the great Italian example, generally prefer to adopt the Indian method and take the integument from the forehead. The operation is by no means common. It may be undertaken to restore the nose wholly or in part, and the amount of healthy integument required for this purpose will be regulated by the want. The ingenuity of the surgeon, too, will be taxed in every case to adapt his operation to its special requirements. He must, however, always be careful to give himself abundance of new material; and, having satisfied himself of the wants of the individual case, and that the parts upon which he is about to operate have long lost all traces of disease, he can then map out upon the centre or lateral portion of the forehead of the patient that portion of integument he proposes to transplant, having planned it beforehand on a piece of paper, plaster, or wash-leather. The shape required for a nose and columna will be such as is indicated in Figs. 337 and 343, the flap measuring three inches in each diameter. The surgeon shall then make raw the whole surface of the old nose to which the flap is to be united, cutting a deep groove close down to the bones bounding the nasal cavity for the reception of the new flap. A sponge may then be firmly pressed upon this raw surface to arrest the bleeding, while the surgeon proceeds to dissect up the integument he had previously marked out upon the forehead. In doing this care should be observed not to bruise or otherwise injure this borrowed skin. The incision should be clean and extend down to the bone. The flap should be dissected up boldly and freely, care being observed to leave a good neck, through which the circulation can be maintained, and to make it long enough to allow of its being turned round. For this purpose it is a good practice to make the incision on the side to which the twist is to be made a little longer than the other.

Fig. 343.



When all bleeding has ceased, the frontal flap, with the external surface still uppermost, should be turned half round and applied to the nasal raw surface, to which it is to be carefully stitched, the columnar portion being well pressed down into the groove made for it and fixed. The new nostrils ought to be supported by oiled cotton-wool or lint, and the surface covered with the same sort of material, to maintain its warmth. The gaping wound on the forehead can then be brought together as far as possible by means of strapping and left to heal by granulation, the operation of skin-grafting expediting repair. The sutures may be removed on the second or third day. For the next month the greatest care is requisite in the dressing of the wound and in keeping the nostrils up with a plug, the one suggested by Langenbeck being the best, and as soon as the new flap has consolidated the neck of integument at the root of the nose may be divided. In the case illustrated (Fig. 344) such a practice was not called for. I operated upon it in 1872 with an excellent result. When the formation of the columna is required, Liston's plan is the one generally employed, and is thus described in his own words:

"Restoration of the columna is an operation which, in this and other civilized coun-

tries, must be more frequently required than the restoration of the whole nose. This latter operation came to be practised in consequence of the frequency of mutilations as a punishment, but the punishment for some of our sins is left to nature, and she generally relents before the whole of the organ disappears. This columna is frequently destroyed by ulceration. The deformity produced by its loss is not far short of that caused by destruction of the whole nose. Happily, after the ulceration has been checked the part can be renewed neatly, safely, and without much suffering to the patient. The operation which I have practised successfully for some years and in many instances is thus performed: The inner surface of the apex is first pared. A sharp-pointed bistoury is then passed through the upper lip—previously stretched and raised by an assistant—close to the ruins of the former columna and about an eighth of an inch on one side of the mesial line. The incision is continued down in a straight direction to the free margin of the lip, and a similar one, parallel to the former, is made on the opposite side of the mesial line, so as to insulate a flap about a quarter of an inch in breadth and composed of skin, mucous membrane, and interposed substance. The fræmulum is then divided and the prolabium of the flap removed. In order to fix a new columna firmly and with accuracy in its proper place, a sewing-needle is passed from without through the apex of the nose and obliquely through the extremity of the elevated flap; a few turns of thread over this suffice to approximate and retain the surfaces. It is to be observed that the flap is not twisted round, as in the operation already detailed, but simply elevated, so as to do away with the risk of failure. Twisting is here unnecessary, for the mucous lining of the lip, forming the outer surface of the columna, readily assumes the color and appearance of integument after exposure for some time. The fixing of the columna having been accomplished, the edges of the lip must be neatly brought together."

Fig. 344.

Appearance of Face after Formation of New Nose.

The sutures can be removed on the third or fourth day, when, as a rule, the parts have cicatrized. The ultimate result of the case depends materially upon the care bestowed upon its after-treatment. In the case illustrated in Fig. 344, which I operated upon several years ago, a gratifying result ensued, the bridge of the nose requiring no second operation. Dr. Lichtenberg has had within the last few years some very successful cases, and the late Mr. Skey had some excellent results in his practice. I saw one that he had operated upon years before, which was very excellent. It is well, however, to remember Mr. Skey's advice when he says, "Let it be the patient who urges the operation."

Of late years Langenbeck has suggested the propriety of dissecting up the periosteum from the frontal bone with the skin flap, so as to give a bony nose, but it is a question how far this osteorhinoplasty is an advantage. The operation has not found much favor.

When only one ala has to be restored, the flap may be taken either from the nose itself or from the cheek, the particulars of the plan being left to the ingenuity of the surgeon to determine.

CHAPTER XVIII.

SURGICAL AFFECTIONS OF THE LARYNX AND TRACHEA.

The larynx and windpipe may be contused from external injury, or the cartilages and trachea rings fractured, the nature and severity of the symptoms following these accidents varying with the character and the amount of injury; some years ago a case came under my care in which the *thyroid* cartilage was fractured obliquely across the body. The accident was attended with much bleeding and cough, but these soon disappeared, and an excellent recovery ensued. In 1877, Dr. A. Corley of Dublin recorded a case in which, after death, the second, third, and possibly the fourth, cartilages of the trachea were fractured and projected unevenly into the tube, associated with suppuration around a necrosed

cricoid cartilage. The preparation was taken from a woman æt. 36 who had been squeezed in the throat some *weeks* before, and was admitted into the Richmond Hospital with dyspnœa, stridulous breathing, congestion of the face, and external signs of inflammation about her throat, and for which tracheotomy had been unsuccessfully performed. There is more danger when the cricoid cartilage is involved than when the thyroid.

The trachea may also be *completely divided subcutaneously*. I saw this in June, 1876, at Guy's Hospital, in the case of a man æt. 47 who was crushed between a barge and the side of a vessel, the prow of the barge striking his neck. The accident was followed by dyspnœa and some emphysema of the neck, but the symptoms were not urgent so long as the erect position was maintained, but the recumbent was impossible. The man lived fifty hours and died quietly. After death the trachea was found to be completely severed below the thyroid body, the two ends being separated for an inch and a half, while the lower end was below the innominate vein.

There was no external bruise to denote the severity of the injury.

Wounds of the Throat.

These are generally made by the hand of the suicide, and consequently have a double interest, the dangers of the local injury being complicated with the peculiar mental condition of the sufferer. It is essential, therefore, for the surgeon to dwell seriously beforehand upon the necessities of these cases, in order that he may be prepared to act with decision in the hour of danger.

In the majority of cases of "cut throat" the wound is only of a superficial nature and simply involves skin or skin and muscle, and does not implicate either the pharynx or the respiratory tract. These cases require no other local treatment than that usually employed for skin wounds, such as sutures and some simple dressing.

When the wound is of a deeper character, it may penetrate into the pharynx and air-passages or involve the deep vessels, the dangers of the case being much determined by the position of the wound.

My colleague, Mr. Durham, in an able article in *Holmes's Surgery* (3d ed.), shows that of 232 unselected cases the wound was

Above the hyoid bone in	17 cases.
Through the thyro-hyoid membrane in	80 "
Through the thyroid cartilage in	42 "
Through the crico-thyroid membrane in	36 "
Into the trachea in	57 "

The respiratory tract was opened in about two-thirds of the cases.

In all cases of cut throat *hemorrhage* as the direct result of a divided or wounded artery or vein is to be apprehended; and although from the deep position of the carotid artery and jugular vein these vessels in the majority of cases escape injury, yet when they are divided death is usually rapid. Partial or complete division of some of the branches of these vessels is, however, not unfrequent.

A man in Guy's, æt. 21, in a fit of despondency cut his throat, and died from profuse hemorrhage into the lung before help could be obtained. The blood was found after death to have come from a divided superior thyroid artery. An inmate of St. George's divided the left common carotid artery and wounded the internal jugular vein with a penknife, and died before the house surgeon could arrive. "A gentleman who committed suicide by cutting deeply between the os hyoides and thyroid cartilage partially divided the external carotid artery on the right side just as it was given off; the flow of blood was immense, and he was found dead within ten minutes of the infliction of the wound" (Fothergillian prize essay for 1836, by my father, the late Mr. T. E. Bryant). In Guy's Museum (Prep. 1711[79]) the left internal jugular vein may be seen divided, the cut being between the thyroid and cricoid cartilages and proving speedily fatal. Prep. 1711[9] shows division of the inferior thyroid artery.

Blood may flow into the trachea and suddenly or slowly cause asphyxia; it may coagulate over the orifice of the larynx with the same result. Mr. Le Gros Clark has also shown (*Surg. Diag.*, 1870) how air may enter the circulation through a partially-divided vein and destroy life in twenty-four hours.

When the incision is *above the hyoid bone* and deep, the tongue may be divided, and the loosened portion, by falling over the orifice of the larynx, may cause sudden death by suffocation. In wounds of this description the surgeon should consequently guard

against the possibility of this contingency by passing a thread through the tongue and drawing it forward.

When the cut is *just above the thyroid cartilage*, the epiglottis may be divided, and this, falling into the larynx, may cause fatal dyspnœa. To prevent this a stitch should be inserted into the divided portion and the parts adjusted. The same result may take place when any portion of the orifice of the larynx has been detached. Indeed, all loose bodies likely to obstruct respiration should be fixed. Emphysema is by no means an uncommon complication of cut throat when the respiratory tract has been opened, and is not, as a rule, a dangerous occurrence. It is more common when the external wound is small.

Inflammation of the air-tubes and lungs is the secondary danger of wounds of the throat involving the air-passages; and when the pharynx or œsophagus has been opened, this risk is aggravated by the possible introduction of food into the trachea. It "was the cause of death in 17 out of 21 fatal cases of cut throat consecutively treated at Guy's Hospital in which the more immediate effects of the injury had been survived" (Durham). Purulent infiltration of the cellular tissue of the neck may also ensue, or œdema of the glottis, and at a later date the air-passages may be obstructed by the cicatrization of the wound or the contraction of the trachea. In exceptional cases a permanent fistulous opening may be left.

The immediate danger of a wound in the throat consequently depends (1) on the quantity of blood lost; (2) on the risk of suffocation from blood flowing into the air-tube; (3) the danger of suffocation by tissues divided and partially separated from their connections obstructing the larynx. The secondary dangers are those of œdema of the larynx and inflammation of the air-passages, and later on from subsequent obstruction of the divided tube by the contraction of new tissue around it or the growth of exuberant granulations round the wound.

Treatment.—The first duty of the surgeon under all circumstances is to *arrest hemorrhage*. Arteries ought to be ligatured or twisted, so also all deep veins when moderate pressure fails to check the flow of blood. A wounded artery or vein should be ligatured above and below the wound. To tie up an opening in a large vein with a lateral ligature is bad practice.

To find the bleeding vessel, the wound may have to be enlarged. The internal jugular vein may be ligatured with a good prospect of a successful result. Durham states that out of 72 cases, 48 recovered. Gross has demonstrated the soundness of the practice (*Amer. Journ. of Med. Sci.*, 1867).

The second duty of the surgeon is to *prevent suffocation*. He should see that the respiratory orifice is kept clear of blood or of any divided structure, such as the tongue or epiglottis. Coagula ought to be speedily removed and respiration encouraged by artificial means when natural processes have failed.

When the larynx or trachea has been wounded, the aim of the surgeon should be to keep the divided pieces of the tube in continuity, and not to allow the upper portion to overlap the lower and thus obstruct the respiration; at the same time, care must be taken to keep the wounded parts sufficiently open to allow of the escape of the mucus, which is always profuse, and to permit the free ingress of air.

If the wound is very extensive and difficulties arise in carrying out the above indications, sutures may be introduced; but it must be left to the surgeon's judgment to decide when they may be necessary, according to the exigences of the individual case. In large wounds, where the parts cannot be kept together, a suture is often of immense benefit; and sutures, when applied, should be put in firmly, including often the whole thickness of the tissues. Their object can only be to fix the divided parts in position and prevent any mechanical obstruction to the respiratory act by their sudden movement. To do this effectually, the measures employed should be boldly executed. The head should be kept forward by the application of bandages, and water dressing applied to the wound itself; constant attention is demanded of the nurse to keep the wound clear of discharge and to see that no obstruction to the breathing take place. The atmosphere the patient breathes should be kept warm and made moist by the introduction of steam, and the wound covered with muslin. The closest attention should be paid to the patient by a skilful nurse, and every mental and bodily want or weakness cared for. As regards nourishment, abundance should always be provided, although it is not such an easy task for the patient to take it.

When the pharynx or œsophagus is extensively opened, the patient should never be allowed to swallow, but be fed by means of a tube passed through either the nose or the

mouth (and not through the wound) and directed with the fingers carefully down the throat into the lower portion of the œsophagus. Through this beef tea, eggs, brandy, and other liquid nourishment such as the symptoms indicate may be periodically administered. I have an instance before me of this kind, and where the patient was kept alive by such means for nearly six weeks, the tube having been passed through the nose. At the end of this time he was able to swallow, and recovery ensued. When acting as dresser to the late Mr. Aston Key, I had a case where the wound was inflicted through the trachea, dividing the œsophagus. In this instance the man was fed twice daily through a tube passed through the mouth and directed with care into the lower œsophageal opening; this practice, being carried on for many weeks, was rewarded by recovery. The plan of treatment just indicated, however, is only rational, and is such as any surgeon would naturally suggest. All complications, such as suppuration in the cellular tissues around the wound, bronchitis, or broncho-pneumonia, are to be dealt with as they arise. Some have suggested the propriety of tracheotomy in severe cases of cut throat, so as to allow the wound to be closed. I am unable, however, to see the advantages offered by this practice in ordinary cases, although in wounds involving the epiglottis or upper part of the larynx, when inflammatory œdema appears as a secondary result, causing obstruction to respiration and threatening life, there is no doubt as to the wisdom of the practice. These cases, however, are uncommon.

Among the most remote dangers of such wounds the mechanical obstruction of exuberant granulations ought to be mentioned, likewise some narrowing of the air-passage from contraction of the cicatrix, and tracheal fistula. These results are common to traumatic and surgical wounds of the part. In Prep. 1711[11], Guy's Hosp. Museum, taken from a patient who had lived for many years after a wound which had involved both the trachea and œsophagus, both the trachea and œsophagus are much contracted above the opening and in a less degree below. In 1873 I was called upon to perform tracheotomy on a man æt. 57 who had cut his throat through the thyroid cartilage sixteen months previously: for eight or ten months he had been suffering from gradually-increasing difficulty of breathing due to the contraction of the air-passage, and this patient has ever since been obliged to wear the canula. In the seventh volume of the *Clin. Soc. Trans.* an interesting case of the kind has been recorded by Mr. H. Lee.

Foreign Bodies in the Windpipe.

There are few accidents which excite more anxiety and alarm to a looker-on than the passage of a foreign body into the larynx or trachea, since the unfortunate subject, in the midst of apparent health or happiness, is suddenly forced to make violent struggles for life. To the spectator death seems imminent, and in the surgeon no less painful feelings are excited; for unless by his art timely relief can be afforded, the danger which is apparent becomes real and death is almost a certainty.

The majority of the victims of such an accident are children, although adults are not exempt from such a contingency.

A foreign body may be inhaled at any moment, a sudden inspiration being sufficient when the mouth is full or holds a foreign body which is smooth, light, or small, such as a seed, fruit-stone, bead, bean, nut, or coin. Vomited matter may likewise be drawn by inspiration into the air-tubes by patients in a state of unconsciousness, as when drunk, under an anæsthetic, or in an epileptic fit. Foreign matter may likewise find an entry into the respiratory tract through a fistulous opening between the œsophagus and trachea the result of simple or cancerous ulceration. The body may be lodged at the orifice of the larynx (Fig. 345), and thus cause sudden asphyxia, or pass into the rima or ventricle, where it may be arrested and give rise to spasm or cause œdema, and, as a consequence, more or less gradual obstruction. It may likewise pass into the trachea or bronchi, the right bronchus being its most common seat, and become either impacted or remain movable. The size and the shape of the foreign body determine many of these points: for, whilst a large one will naturally be arrested at the orifice of the larynx, a small one will probably pass through. A jagged and light body such as a seed or piece of nutshell would be more likely to be caught in the rima than a small round body such as a bean. A light body will remain movable, whereas a heavier one may become impacted.

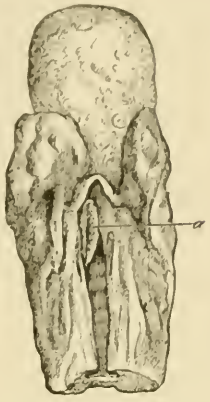
A piece of meat may become impacted in the rima glottidis and cause instantaneous death (Prep. Guy's Hosp. Mus. 1710).

In the case of a child æt. 2½ on whom I unsuccessfully operated in 1864, a date-stone was found impacted in the right bronchus, while its upper end was pressing against the

left side of the trachea and exciting ulceration (Fig. 346). The child lived four days. In another case, recorded in my *Clinical Surgery*, Part II., a bean was firmly impacted in the right bronchus, causing complete obstruction to the right lung.

The fact, pointed out by Goodall of Dublin, that the septum at the division of the trachea is somewhat to the left of the median line, is probably the explanation of the right bronchus being more frequently the seat of the foreign body than the left. The larger size of the right bronchus doubtless favors this tendency.

Fig. 345.



Bone in Larynx, causing Death. (Taken from a child eleven months old. Prep. 1710[5].)

Fig. 346.

Date-Stone Impacted in Right Bronchus. (Prep. 1717[15].)

The SYMPTOMS which attend the entrance of a foreign body into the air-passages are somewhat characteristic, although those that follow are often obscure. The most typical is a violent convulsive cough *coming on abruptly*, followed by difficult respiration and a feeling of suffocation, this spasmodic cough being likely to recur at intervals on any movement and as long as the foreign body is loose.

When the foreign body is lodged near the rima and impacted, the voice is altered in character, *whistling* or *stridulous*, and there may be some tenderness of the larynx on manipulation, or pain. When an extraneous body is in the ventricles, the spasmodic derangement to which it gives rise too often proves speedily fatal. In children rapid suffocation is a common result of such a cause, death being more frequent from spasm of the glottis than from mechanical obstruction by the foreign body, though when the body is fixed in the larynx chronic obstruction often comes on from the œdema of the larynx excited by its presence.

When the breathing of the patient is at times natural and at others disturbed by a paroxysm of cough or dyspnœa, and when these symptoms are brought on by any movement or violent respiratory effort, it is probable that the foreign body is loose in the trachea or in one of its divisions; indeed, patients are conscious occasionally of the movement of the body. When by auscultation it can be made out that air enters one lung freely and the other feebly, the exact seat of impaction of the foreign body is indicated, and the amount of dyspnœa present will depend upon the tightness of the impaction.

When the extraneous body has passed through the larynx into the trachea, there may be long intervals of repose between the attacks of laryngeal spasm, but any spasm may prove fatal.

Many cases are now on record in which foreign bodies, particularly coins, have been impacted in a bronchus and have given rise to no urgent symptoms for years. Dupuytren in one of his lectures given in 1833 relates a case where a coin was known to have been in the air-passage for ten years without producing any very distressing effects, and was found after death to occupy a tubercular excavation. Professor Gross gives a case in which a portion of bone is said to have been coughed up after having been retained for sixty years. Cases such as these, however, should never allow the surgeon to rest satisfied or permit a foreign body to remain in the air-passages, for so long as it does death may at any moment be suddenly produced by convulsive laryngeal spasm, or more slowly by broncho-pneumonia.

Difficulty of breathing is not uncommon as a consequence of the arrest of food in the œsophagus or lower part of the pharynx, and at first sight the surgeon might think that the symptoms are due to the presence of some foreign body in the air-passage. When doubt exists, the patient should be made to swallow; in laryngeal obstruction no difficulty will be experienced by the act, whereas in pharyngeal it will be impossible. Under other circumstances a probang may be carefully introduced into the œsophagus, and in every case a careful exploration of the throat and pharynx with the finger should be made. When the foreign body is impacted in the pharynx and cannot be removed, and laryngeal spasm threatens life, the windpipe may require to be opened. The surgeon should always hesitate to employ force in pressing a foreign body downward.

Treatment.—Given the diagnosis of a foreign body in the windpipe, the duty of the surgeon plainly is to endeavor to remove it. There should be no deviation from this resolution, because so long as a foreign body remains in the air-passage sudden death from spasm of the larynx is imminent, and the first spasm may prove fatal, the spasm being produced by any movement of the foreign body. The surgeon should never allow himself to be misled by the mildness of the symptoms nor by the knowledge that in rare instances foreign bodies have remained in the passage for years, and even then been expelled, since such cases are exceptional. The accident is one that will inevitably destroy life, although it must be doubtful at what time or in what form danger may appear.

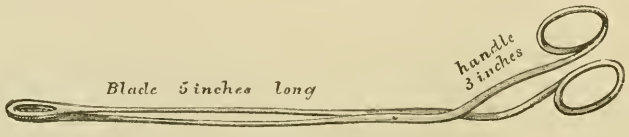
In all urgent cases in which spasm of the larynx threatens life *tracheotomy* should be performed, because with an opening in the trachea fatal spasm is impossible, and the surgeon may then proceed to investigate the case. In cases in which life appears to be extinguished the same practice should be adopted, artificial respiration being subsequently maintained. Should the symptoms point to the larynx as the seat of the impaction, the upper orifice should be closely examined by the finger introduced through the mouth, and a full-sized bougie or catheter—or, what is better, a small piece of sponge held by forceps or fixed on a handle—introduced from below through the wound into the larynx. By these measures most foreign bodies caught and impacted in the larynx itself may be removed. In exceptional cases where these measures fail the surgeon may be called upon to lay open the larynx. The laryngoscope at times will be an invaluable aid in guiding to the position of the foreign body and in effecting its extraction. It is only applicable, however, in adults. When the position of the foreign body is known, its removal may be facilitated by curved forceps.

Laryngotomy is scarcely applicable to these cases, the majority being found in children. In children the opening in the trachea should always be as high as possible, and there is no objection to dividing the cricoid cartilage (*laryngo-tracheotomy*) to reach the larynx. When the foreign body is so fixed in the larynx as to be immovable by the means suggested, the thyroid cartilage must be laid open by increasing the incision upward. In doing this the larynx will be fully exposed and the removal of the body facilitated. When the foreign body has passed the larynx and is in the trachea, a free opening should be made low down in the passage; and when this is done, it not unfrequently happens that the foreign body is expelled. Should this not happen and the foreign body is heavy and smooth, the patient may be inverted and succussion employed—that is, the patient should be patted sharply on the back or shaken with the view of dislodging it. But this proceeding should not be employed until the trachea has been opened. Should the foreign body be light, it may possibly be extracted by means of the "sucker" figured 352 at page 609. The rubber tube for this purpose should be long.

Some surgeons advise the introduction of forceps or other instrument through the wound into the trachea for the removal of the foreign body, and in recent times success has followed the practice. Thus in May, 1876, Mr. Maunder extracted by means of a loop of silver wire through an opening made in the trachea a glass sleeve-link from the left bronchus of a boy æt. 13. Mr. Hulke in August, 1876, hooked out of the right bronchus of a woman æt. 37 the outer tube of a tracheotomy canula by means of a piece of German silver wire bent into a hook, and Mr. Lucas on November 16, 1877, removed by means of forceps the same kind of thing from the left bronchus of a man æt. 57, the tube having been in the bronchus for seven weeks.

Fig. 347 represents an excellent pair of forceps for this purpose. It was made for Dr. S. D. Gross of Louisville before 1854, and is taken from his book on *Foreign Bodies*

Fig. 347.



Gross's Trachea Forceps.

in the Air-Passages. "They," as described by him, "are composed of silver, and are a little upward of eight inches in length. The handle is considerably curved on the flat and has two rings for the thumb and finger. The blades, which are rounded and very slender, are five inches long and terminate each in a fenestrated extremity nine lines in

length by three lines in width, the outer surface being smooth and convex, the inner flat and slightly serrated. The blades when shut slightly overlap each other. The weight of the instrument is a little over five drachms. The instrument, being long and slender, may be used as a probe; being composed of silver, it may be bent at any point and in any direction; and being delicate, it cannot impede the passage of air during its use."

When these means fail to remove the foreign body, the patient must be left, but the wound in the air-tube should be kept open.

If the foreign body be in the larynx, the canula may be introduced; but when in the trachea or bronchus, its retention is injurious, as it prevents the escape of the substance. Under these circumstances Hilton's suggestion to form a transverse valvular opening in the trachea is undoubtedly the best, since it readily allows the escape of the foreign body when impelled against its surface. The cutting out of a portion of the trachea is quite unnecessary. A better practice consists in making some provision for the tracheal wound to be held open by hooks, by some such apparatus as Golding-Bird's tracheal dilator. In one case in which the trachea was deep I managed to keep the tracheal wound open by means of a divided ring of strong wire embracing the neck, its two ends being made to hook into the opening in the air-passage and acting as retractors. In another I held the wound apart by means of a wire instrument made on the principle of the eye speculum. When efforts fail at one time for the removal of the body, they may be successful at another. Mr. Brunel's well-known case is one in point. Mr. Durham informs us, from an analysis of 636 cases of foreign bodies in the air-passages, that death resulted in 41 per cent. when no operation was performed, and in 23 per cent. when operative measures were resorted to, and hence the chances are greatly in favor of the latter practice. The foreign body having been removed, the chief danger has passed. There may be some inflammation of the air-passage as a result of the irritation of the foreign body, but this usually subsides on the removal of its cause; in exceptional instances it may prove troublesome, if not fatal. The nature of the substance has also much influence in determining this result, smooth bodies being slightly irritating, while jagged are more so. The operation of tracheotomy doubtless does something toward aggravating the tendency to inflammation. Such a complication should be treated on rational principles, but in the majority of instances the inflammation will subside spontaneously on the removal of the offending body. Water dressing to the wound and a warm, moist atmosphere are the two essential points of practice to be attended to after the removal of the cause, and, as a rule, convalescence speedily follows. Anæsthetics ought always to be administered in these cases when operative interference is called for.

Scald of the Larynx.

This somewhat common accident is engendered amongst the poor from the habit of feeding their children out of a teapot. The child, when thirsty and alone, being accustomed to drink from the "spout," tries the same experiment with the kettle of boiling water, and scalds the pharynx and orifice of the larynx, so that œdema of the part follows, in the same manner as a blister arises by the application of boiling water or steam to any other tissue.

The symptoms caused by such an accident appear, as a rule, very speedily, and the small chink of the glottis soon closes; as a consequence, a fatal result ensues unless early relief can be obtained.

Symptoms.—In some cases the mouth, with the soft palate, tongue, and fauces, will be found swollen and vesicated. There will also be difficulty in swallowing, and also alteration in the character of the voice. The respiration rapidly becomes affected and a spasmodic croupy cough appears, with stridulous breathing. These symptoms may become gradually or rapidly worse, and may be complicated with attacks of spasmodic dyspnœa at long or short intervals; but when these attacks appear, the condition is extremely dangerous, as any spasm may prove fatal. A somewhat similar result may arise from the intentional or accidental swallowing of any corrosive poison or acid or from the inhalation of a flame.

Treatment.—In a fair proportion of these cases little other treatment than a warm bed, the application of a hot sponge to the larynx, and the inhalation of warm moist air is ever needed; the symptoms subside as rapidly as they appear, three or four days seeing the worst of the case; and in these mild cases the laryngeal symptoms are probably never severe. When laryngeal symptoms exist, accompanied by spasm, the case assumes a threatening aspect; indeed, the first spasm may be the last. I have notes of the case

of a child in whom the symptoms were so slight that no anxiety was felt, but a single spasm took place two hours and a half after the accident and put an end to life.

When symptoms are severe, the operation of tracheotomy should be performed; indeed, I am disposed to recommend this operation in every case in which the symptoms are progressing and laryngeal spasms coexist. To postpone it too long, till the lungs become gorged with blood, and consequently disposed to inflammatory action, and the powers of the patient are depressed, is a timid, and certainly unsuccessful, practice. In the opinion of many good surgeons, I know, it is thought desirable to pospone operative interference as long as possible—"to watch and wait." In this I do not agree. When laryngeal spasms exist with mechanical obstruction, nothing but opening the windpipe places the patient in safety. Out of 9 cases consecutively treated by tracheotomy 5 recovered. The statistics, however, of my colleague, Mr. Durham, are less favorable, 35 out of 51 cases terminating fatally.

In some instances the scarification or puncturing of the œdematous opening of the larynx and epiglottis gives great relief. I have been accustomed to do this by means of an ordinary tenaculum or mounted needle. Mr. Tudor, formerly of the Dreadnaught, has invented a useful instrument for the purpose, called an epiglottome. The punctures into the œdematous tissue may be free and never seem to do harm. Drs. Wallace and Bevan of Dublin have spoken very strongly in favor of the calomel treatment, two or three grains being given every hour until the symptoms are relieved, and Dr. Croly uses inunction at the same time. Other surgeons speak well of antimony, and doubtless it is a drug that should always be given in doses of one, two, or three minims of the antimonial wine every quarter of an hour until some effect has been made upon the disease, and then at longer intervals. The best local application to the larynx is the hot sponge. A blister over the upper part of the sternum sometimes does good, and in exceptional cases leeches to the larynx may be used. The time required by all these remedies to produce their effects is too long and their action is too uncertain to allow the surgeon to depend upon them in acute cases; as accessories to the treatment they are of use, but as means of preventing death when obstruction exists and spasms are frequent they are not to be relied upon. When an operation is performed, it should be tracheotomy. Laryngotomy is inapplicable and too near to the disease. Anæsthetics may be given without fear.

Diseases of the Larynx requiring Tracheotomy.

Since the introduction of the laryngoscope our knowledge of the disease of the larynx has so much increased, and the treatment of its different affections so much improved, that the subject has become somewhat extensive—so extensive, indeed, that enterprising members of our profession have contrived to turn it into a specialty. This is a subject of regret in a certain sense, as it tends to make the bulk of the profession, and with it the student, look upon laryngeal affections as difficult subjects of investigation and beyond the reach of average skill. This is not, however, in any way correct, for the use of the laryngoscope or throat speculum is no more difficult than that of any other instrument. To use it neatly and efficiently requires skill and some practice, but the same efforts are also essential to every other surgical investigation.

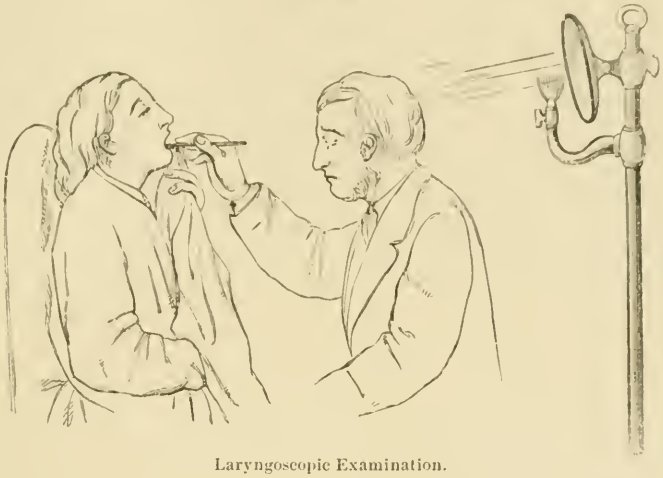
The first laryngoscope was introduced to the profession in 1829 by the late Dr. B. G. Babington of Guy's Hospital, who under the term "glottiscope" invented an instrument composed of a mirror fixed to a wire handle, which, being fixed against the palate whilst the tongue was depressed, enabled him to view the upper part of the larynx. Garcia, the singer, in 1855 gave an impulse to the idea by throwing the sun's rays into the back of his mouth by means of a mirror held in his left hand, and so from a dentist's reflector introduced into his mouth he could witness the movements of his larynx in the looking-glass. But to Drs. Czermak and Turck is unquestionably due the credit of having applied this mode of investigation in a scientific way to the diagnosis of laryngeal disease. They employed, however, artificial illumination instead of solar, adopting the practice of Helmholtz in ophthalmoscopic operations.

The ordinary mode of application of the instrument is very simple. The patient sits with his back to a good light; that of the sun is the best, but a moderator, gas, or electric lamp will suffice. The lamp should be in a line with the patient's face and on his right side; the surgeon, with the mirror fastened round his head, faces the light and reflects it on the patient. The patient is then directed to open his mouth, protrude his tongue, and hold it with a handkerchief; a warmed mirror is then introduced to the back of the fauces, while the tongue at this time is depressed. The rays of light from the frontal

mirror are then made to fall upon the mirror in the pharynx, and with a little arrangement the glottis and all the parts around, above or below, may be carefully examined.

The pharyngeal mirror may also be well illuminated by simply projecting the rays of light from a large reflector fastened beind a gas or moderator lamp, as seen in Fig. 348.

FIG. 348.



Laryngoscopic Examination.

I have employed this method for many years, and found it more effectual than any other.

It is impossible in the following chapter to give a full description of all the different affections to which the larynx is liable, nor would it be consistent with the object I have in view, since laryngeal affections come as much under the notice of the physician as of the surgeon, and the latter is consulted only when medicine has failed to relieve symptoms and evidence exists of some progressive affection which, by causing obstruction to the respiratory process, threatens life. In the following chapter I propose, therefore, to consider the diseases of the larynx in their surgical aspect only, and to view them simply in their relation to tracheotomy or other operative interference.

In a general way it may be asserted that tracheotomy may be called for under any circumstances in which obstruction exists to the respiratory act, such as in pharyngeal affections mechanically affecting the larynx; in laryngeal disease, acute or chronic, inflammatory or otherwise; or in tumors pressing from without upon the windpipe in some part of its course. It may also be possibly required for some temporary purpose connected with operative surgery, to ensure the maintenance of the respiratory act during the removal of a large pharyngeal or maxillary tumor.

PHARYNGEAL AFFECTIONS OBSTRUCTING THE RESPIRATION.

Abscesses about the pharynx or tonsils at times cause laryngeal obstruction, and such a complication should be treated by puncturing the abscess with a guarded bistoury. Inflammatory and ulcerating affections of the throat, more particularly those called diphtheritic, are apt to spread to the larynx and set up a laryngitis.

Tumors of the pharynx or tonsils are occasionally met with pressing upon the larynx and interfering with its functions; a cyst may develop at the back of the tongue in front of the epiglottis and by its size almost close the laryngeal orifice, or a naso-pharyngeal tumor may so press downward as not only to threaten life by suffocation, but to cause death. In a large naso-pharyngeal tumor I had to treat the former condition was met with, but relief was given by the removal of the growth. In another case, one of cancerous tumor of the pharynx above the soft palate, occurring in a boy æt. 18, and which rapidly recurred after its removal, death ensued from suffocation, tracheotomy having been rejected. Suffocation from simple enlargement of the tonsils I believe to be unknown, although it has occurred from cancerous disease.

Affections of the Larynx requiring Tracheotomy.

Inflammatory affections can never exist long without causing some closure of the glottis, thereby endangering life. In acute laryngitis of catarrhal origin, in membranous and in diphtheritic croup, a few hours may be sufficient to produce this effect, from either œdema of the larynx, suppuration of the larynx, or the effusion of a false membrane. In all the result is the same—mechanical closure of the glottis complicated with spasm—and in all the important question presents itself as to whether medical treatment can be sufficient to check the disease or surgical aid in the way of operative interference is required. Trousseau, our great authority in this matter of tracheotomy in croup, maintained strongly that the earlier the operation is performed the greater are the chances of success, that it ought to be performed before death is imminent, and that, to whatever degree asphyxia may have proceeded, it ought to be tried, for in the most desperate cases there is a chance of success provided the local lesion, the croup, constitutes the chief danger of the disease. In these views I entirely concur; they are physiologically sound and clinically correct. Indeed, the operation should be performed in all cases when the disease is steadily progressing and is unaffected by medical treatment, and it should be undertaken *before* asphyxia, carbonæmia, or severe blood poisoning has taken place. To operate before any evidence of deficient oxygenation of the blood, as shown by lividity of the lips, etc., exists would be bad practice, and to postpone operative interference when such lividity is present is to throw away a chance. With retraction of the epigastrium and intercostal spaces and supraclavicular depression in inspiration, with or without cyanosis, any delay would be dangerous. It is a clinical fact that in a large number of cases the extension of disease is arrested by the operation, though when the lungs have become gorged with blood unfit for circulation by too protracted delay in operating a successful issue can hardly be looked for.

In chronic laryngitis, whether tubercular, syphilitic, or otherwise, tracheotomy may be required to prevent impending death or as a means of cure. For the first indication it should not be postponed too long, for "too long" often means "too late," some spasmodic attack carrying off the patient. When these attacks consequently appear and recur, tracheotomy should be performed.

Tracheotomy as a means of cure in chronic inflammatory laryngeal affections is not sufficiently practised. "It has been hitherto generally performed in the class of cases to which I have just alluded—to rescue patients from the danger of impending suffocation, and to prolong life when threatened from laryngeal disease; and yet it must have struck most men, when watching cases which have been operated upon under these circumstances, how rapidly all laryngeal symptoms disappear and ulcerative action undergoes a reparative process, both in the pharynx and larynx, after a new passage has been obtained for the respiratory act and complete quiescence of the parts has been secured by means of tracheotomy." I have a strong opinion, therefore, that it would be wise to perform the operation in ulcerative laryngeal affections at an earlier period than has hitherto been practised, with a view of arresting the progress of the disease, and probably of saving the larynx as a respiratory and vocal organ, anticipating the time when the operation may be demanded for the purpose of preventing impending suffocation. In the first volume of the *Clinical Society's Transactions* I published some cases illustrative of these views, and my more recent experience has confirmed them. It should not be performed in the very early period of the disease, whilst any reasonable hope exists that by medical or local treatment a successful result may be secured, but it should be undertaken in all cases of progressive disease when local and general treatment have failed to make any impression on the local affection.

Tumors of the larynx are not very uncommon. Children are liable to suffer from warty growths of the rima or the surrounding parts, and in adults epithelial tumors are likewise met with. Cancerous growths involving the larynx are also on record. Mr. Holmes, in his admirable work *On Children's Diseases*, informs us that out of twenty-eight cases of tumor of the larynx which he tabulated from the *Transactions of the Pathological Society*, seven were cancerous. He also points out the fact that in cases of tumors of this region life is threatened by the occasional fits of spasmodic dyspnœa, the patient being often well in the intervals; and when these recur very severely, it becomes necessary to perform tracheotomy.

When warty growths exist and it is impossible to remove them from above by means of the forceps or snare, aided by the laryngoscope, the larynx may be laid open fearlessly in the middle line and the tumor removed. I did this in 1871, in a child æt. 3, for exten-

sive warty disease of the epiglottis and glottis with complete success, and my colleagues, Mr. Durham and Mr. Davies-Colley, have done the same. I have also by the operation of tracheotomy prolonged for many months the life of a man who had a cancerous laryngeal tumor obstructing respiration.

Tracheotomy may also be required for tumors of the neck pressing upon the larynx. I have been called upon to operate under these circumstances on three occasions. It may likewise be demanded for intrathoracic tumors, aneurismal or otherwise, on account of sudden laryngeal spasm due either to pressure on the recurrent laryngeal nerve or to compression of the trachea, Dr. Bristowe having well shown (*St. Thomas's Hosp. Rep.*, vol. iii., 1872) "that destruction of the functional activity of one recurrent laryngeal nerve is marked by paralysis of the corresponding vocal cord, which can be recognized by means of the laryngoscope, by impairment of the musical quality of the voice, and (probably) by some difficulty of swallowing, owing to the tendency of food to slip into the larynx, but is not necessarily attended with stridor or dyspnœa; and, in the second place, that compression of the trachea involves stridor and difficulty of breathing, which is often paroxysmal and liable to end in sudden death, but that it does not of itself interfere with perfect intonation, excepting only in so far as it may render the voice weak by diminishing the supply of wind to the vocal organs."

Excision of the Larynx.

This operation was first performed by P. H. Watson in 1866, and later by Billroth of Vienna in 1873, for cancerous disease, Heine of Prague, Moriz Schmidt of Frankfort-on-the-Maine, Langenbeck of Berlin, Caselli of Milan, and Gussenbauer of Prague, but the success that has attended it is not such as to lead me to recommend the operation. The operation can be performed by making a transverse incision parallel to and above the hyoid bone and a vertical one at a right angle to it over the larynx, the dissection of the larynx being made from above. Dr. Foulis of Glasgow has, however, performed this operation upon a man æt. 28 for recurrent papillary sarcoma with success. In the operation he left the epiglottis (*Lancet*, 1877, vol. ii., and 1878, vol. i.).

Bronchotomy, Tracheotomy, Laryngotomy.

Any opening made by the surgeon into the windpipe is called *bronchotomy;* when between the thyroid and cricoid cartilages, it is called *laryngotomy;* when below the cricoid into the trachea, *tracheotomy;* and when the incision includes the cricoid cartilage and upper rings of the trachea it is called *laryngo-tracheotomy.* In all these operations the object is the same—either to admit air into the lungs when some obstruction exists in or above the larynx, or to facilitate the removal of a foreign body or morbid growth. Dismissing the general term "bronchotomy" from our consideration, the latter two operations claim our notice and are applicable in two different classes of cases. When the cause of obstruction is *above* the larynx, laryngotomy may be performed: when *in* the larynx, tracheotomy or laryngo-tracheotomy should always be preferred. For the removal of a foreign body or new growth tracheotomy is the better operation, the incision at times being extended either upward into the larynx, through the cricoid and thyroid cartilages, or downward as far as needed. For both operations anæsthetics may be safely administered, unless asphyxia be profound, when it is not required.

Laryngotomy is not an operation to be performed on children, the crico-thyroid space at an early period of life being too small to allow of a free opening being made into it. It is only applicable in adults when obstruction to respiration exists above the rima glottidis, such as that caused by an impacted mass of food or some pharyngeal growth. For tetanus or any other spasmodic affection of the larynx threatening life it may likewise be employed, as well as in operations on the palate, pharynx, etc., in which it is advisable to ensure the free passage of air into the lungs during manipulation, although under these latter circumstances tracheotomy and the use of Dr. Trendelenburg's plug are to be preferred (Fig. 228).

To perform the operation, the patient should be placed on the back with the thorax raised, shoulders drawn down, and head extended. The operator should stand on the patient's right side and feel for the thyroid cartilage, at the lower border of which the windpipe is to be opened. To do this a vertical incision is to be made in the median line, about one inch long, cutting through all the tissues covering in the crico-thyroid membrane. The membrane should then be opened transversely with a knife. The crico-

thyroid arteries cross this space, and may possibly be divided, giving rise to some little hemorrhage. Sir W. Fergusson has recorded a case narrated to him by Professor Turner of Edinburgh in which a fatal hemorrhage occurred from these vessels. Such a danger is, however, very remote.

Tracheotomy is by no means a simple operation, but under all circumstances is delicate, requiring coolness and caution, and when performed hurriedly is too often made

FIG. 349.

Operation of Tracheotomy.

difficult, and even dangerous. In very young children it is always troublesome. The surgeon may at times be called upon to be rapid in his movements, but never should be hurried. As the result of hurry many are the mistakes that might be enumerated, such as wounding of the innominate or carotid artery, the opening of the œsophagus through the trachea, the puncturing of the spine through both these tubes, etc.

The patient should be placed as in laryngotomy, while the surgeon stands on the right side. The different points in the neck must then be made out and the existence of any large vein in the line of incision looked for, and, if present, avoided. The best position for opening the trachea is half an inch below the cricoid cartilage or below the isthmus of the thyroid gland; but this is not a point of so much importance as some surgeons would lead us to suppose. In infants it may be disregarded. An incision about two inches long may then be made through all the soft parts covering the trachea. This may be done rapidly when needed, deliberately when possible, care being taken at the same time, by means of retractors, not to displace the parts. During this step of the operation the surgeon's left index finger should be his guide, and it should be steadily kept over the trachea till the rings are felt, while it will also intimate the presence of any arteries near the tube or in the line of incision. The rings once recognized, the trachea may be opened with the knife, its edge being turned upward, and the opening made parallel with the nail of the left index finger, which is in the wound. When the windpipe has been opened, air, blood, and mucus will at once bubble up. The canula with its pilot should then be introduced into the trachea through the opening which the left index finger has covered, this finger acting all through as a guide and director, and, lastly, as a plug to the wound till the canula has been introduced. The eye of the operator should be directed to the end of his left index finger.

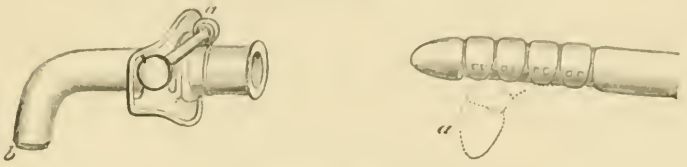
In opening the trachea some prefer to use the hook to draw it forward, and in cases in which much bleeding exists or the trachea is very deep it may be employed. I have, however, rarely used it, having more confidence in the use of the left index finger as a guide throughout.

Some employ, also, a dilator to keep the wound open till the tube is introduced, while others prefer to open the trachea with a sharp trocar. The former practice is unnecessary and the latter dangerous, as a sharp trocar may perforate the trachea altogether and enter the œsophagus—an accident I have known to occur, or, if it slip by the side of the windpipe, the large vessels will be endangered. With respect to the canula, Fuller's bivalve has hitherto met with general approval, and Durham's "lobster-tail" canula (Fig. 350) has been much liked, though the best by far is the ball-and-socket instrument

(Fig. 351) I had made some years ago, its great advantage consisting in the mobility of the tube with the trachea, the neck plate being fixed.

When this canula is made of aluminium, great advantages are gained, an aluminium instrument weighing only sixty grains, when a silver one weighs two hundred and sixty.

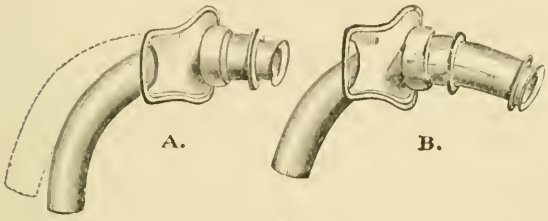
Fig. 350.



Durham's Canula and Pilot.

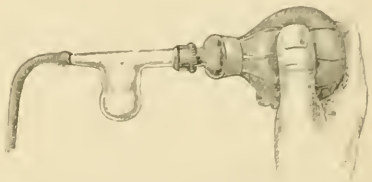
Indeed, the aluminium is lighter by ten grains than the vulcanite. The rigid tube, when required to be worn for long, too often excites ulceration by the pressure of its free end on the trachea, which may extend into the innominate artery. Mr. Morant Baker has

Fig. 351.



Bryant's Canula.
A, Full length. B, Shortened.

Fig. 352.



Tracheal Aspirator for the Removal of Mucus, Lymph, or possibly a Foreign Body, from the Air-Passages.

recently introduced into practice a tube made of vulcanized red india-rubber which seems to answer well, and may be employed on the second or third day after the operation has been performed. Every metal canula should be double, and every canula fixed in position by a piece of silk or tape passed through the shield and fastened round the nape of the neck.

After-Treatment.—After the operation the atmosphere of the room should be kept warm and moist by the admission of steam, care being taken that the air is not saturated with vapor. The wound ought to be kept clean; strapping and sutures are rarely required; water dressing or sweet oil is probably the best local application. Great care should be observed to keep the orifice of the canula free from mucus and the inner tube clean, a "sucker" (Fig. 352) composed of a rubber bottle, glass tube, and rubber spout small enough to enter the canula, and long enough to pass down the trachea if required, being always at hand for the purpose. This instrument does away with the nasty and dangerous practice of sucking by the mouth. After the operation a piece of muslin should be placed over the tube, to prevent the entrance of foreign bodies.

Complications.—If the operation should be complicated by hemorrhage, the surgeon must not be alarmed. When arterial, it must be arrested before the trachea is opened, either by the application of a ligature or by torsion; if venous, the sooner the trachea is opened, the better, for a few good inspirations do more to relieve the venous congestion which is almost always present when tracheotomy is demanded than any other attempt to check bleeding. As soon as the tube has been introduced the patient may be rolled over on his side, to allow the blood to run away from the tracheal wound. A piece of sponge applied with some pressure over the wound is generally enough to arrest all venous bleeding, unless some large venous trunk has been opened. I have never known hemorrhage of this kind to be so copious as to interfere with the operation, or to be so persistent as not to cease readily on its completion. If the surgeon stops his operation till bleeding has ceased, he will too often wait till, with the life of his patient, the necessity of the operation has passed away.

Opening of the Trachea.—There can be little doubt that in patients after puberty the trachea should generally be opened below the isthmus of the thyroid gland, but in infants and young children, where the trachea is deeply placed and the neck fat

and short, the nearer the opening is to the cricoid cartilage, the better. For several years I have been in the habit of opening the trachea immediately below the cricoid ring, and never have hesitated to divide the latter when more room is required. In many instances I have gone through the isthmus of the thyroid, and never had any reason to regret it; nay, I am almost tempted to believe that the dangers of its division are really theoretical, and practically may be disregarded. Of this I am convinced—that the nearer the tracheal opening is to the lower border of the cricoid ring, the better is the operation. If the opening be too small at the first puncture, a second should be made rather than grope about with retractors and instruments to find the original opening. The tracheal tube need not be very large, for Mr. Marsh has demonstrated (*St. Barth. Hosp. Report*, vol. iii.) that the rima glottidis is the smallest part of the air-tube. In dividing the soft tissues and fascia on the trachea care should be taken to do so freely, to guard against the mediastinal emphysema which Dr. Champneys has shown to be such a common cause of death after tracheotomy (*Med.-Chir. Trans.*, 1882 and 1883), from the escape of air beneath the deep cervical fascia.

Under all circumstances the operation should be completed, and even in apparently hopeless cases artificial respiration should be kept up through the wound. Mr. Holmes has recorded a case of Mr. Tatum's in which it was maintained for two hours with ultimate success.

When tracheotomy has been performed for thyroidal tumors pressing upon the trachea, the surgeon should have at hand a long perforated tube small enough to be introduced through the canula, as the tumor may so overlap the trachea as to cause obstruction below the point at which the operation is performed. For the want of such an instrument I lost a patient whom I saw with Sir Risdon Bennett, while by its aid I was enabled to save another for several days, the elastic tube being pressed through the canula, past the obstruction, into the lungs. I have had such a tube adapted to my canula as a pilot to introduce it. It is almost needless to say that the canula should be removed from the trachea as soon as respiration has been re-established by the natural passage, and that it should on no account be left in more than three months. When required longer, a new one should be substituted, since the canula rapidly undergoes oxidization in the trachea and becomes liable to break. In a patient of my own, where the tube had been worn six months, half its circumference close to the neck shield had been destroyed, and the slightest violence would have broken the instrument in the trachea. The vulcanite, and probably the aluminium, canula is good for constant use.

Mr. T. Smith in an excellent paper (*Med.-Chir. Trans.*, 1865) has given a good summary of the obstacles to the re-establishment of natural respiration after tracheotomy, and he has shown that the chief causes are a narrowing of the passage of the larynx by granulations around the canula, and the impairment or loss of those functions of the muscles of the larynx which regulate the admission of air through the rima. There may likewise be a persistence of the original cause which necessitated the performance of the operation, the effects of the original disease, or the closure of the vocal cords from the cicatrization of old ulceration. In three cases now under my observation in which tracheotomy has been performed for chronic ulceration of the larynx the rima has so contracted as to be impervious in two, and in one the opening is so small as to be insufficient for respiration, although enough for speaking purposes.

To help the surgeon to judge of the patency of the glottis, Luer has invented a bullet valve to be adapted to the orifice of the canula, and Mr. T. Smith an india-rubber one which seems equally efficient and is a simpler instrument. Either may be employed, as anything that helps to decide when the canula may be removed with safety is of value.

CHAPTER XIX.

SURGERY OF THE CHEST.

Contusions.

The chest is liable to be contused, and severe contusions are not unfrequently followed by extensive effusions of blood. The swelling under these circumstances occurs suddenly after the injury and appears with the discoloration of a bruise. These cases, as a rule, do well if left alone, the extravasated blood becoming absorbed, but in exceptional examples the blood may break down and give rise to suppuration.

Treatment.—When the contusion is slight, the application of a cold lead lotion is all that is necessary, and in more severe examples, where extravasation is great, there is nothing equal to the application of cold, in the form either of the metallic tube (Fig. 9) or of ice. In obstinate cases the use of some stimulating liniment hastens recovery, and the administration of tonics is always of value.

When the effused blood breaks down and suppuration ensues, the abscess must be opened; but the surgeon need be in no hurry to conclude that the effused blood is incapable of being absorbed nor that pus has formed, since it is a familiar fact that blood may remain fluid in the tissues for a long period and yet be eventually removed by absorption.

Rupture of the Pectoral Muscle

is an accident which may take place from a forcible strain applied to the muscle when unprepared for action or from external violence. I have seen a case in which the muscle, from the forcible drawing back of the arm, was nearly torn across about its centre, in which the fingers could be inserted between the divided ends of the torn muscle, and there was much effusion of blood. In that case the arm was bound to the side by a bandage and ice locally applied, and three months subsequently some power existed in the muscle. The amount of repair which is to be expected in these cases depends upon the severity of the injury and the care with which the parts are kept in position during its progress. As a general rule, the two ends of the divided muscle should be kept in contact for at least two months before movement is allowed. This accident is not rare in children from forcible dragging of the arm.

Fractured Ribs

form about a tenth part of the cases of fracture admitted into a large hospital. This accident is less common in children and young adults than in subjects past middle age, on account of the elasticity of the ribs. In the aged the ribs become so brittle that they break under slight external violence, and in rare cases from the violence of a cough. I have seen this occur in two patients between sixty and seventy years of age, the one a male and the other a female; in neither were there any signs of disease, and both of the persons are now alive.

Fractured ribs are not uncommon accidents in lunatic asylums, and generally arise from direct violence, though it would be wrong to assume that they are always the result of ill-treatment, as patients, when much excited, will unconsciously inflict most serious injuries on themselves; and it has been proved that the bones of many of the insane are in an abnormally brittle state. This is especially true in the disease known as "general paralysis of the insane." Dr. Campbell Brown of Liverpool has analyzed the ribs of general paralytics, and states that "the ratio of organic constituents to earthy matters is much greater, while the ratio of lime to phosphoric acid is distinctly less, in the ribs of paralytics than in those of healthy adults. There are the same differences between the composition of healthy ribs and those of paralytics as between the composition of the adult large bones and those of the fœtus. And generally the composition in cases of paralysis approaches that observed in cases of osteo-malacia." Some striking cases bearing on this subject are recorded by Dr. Hearder in the *Journ. of Mental Sci.* for 1871.

In the majority of cases, the injury being the result of *direct* violence, the fracture takes place at the part struck, and so the ribs are often driven in. In the minority, where

it is due to *indirect* violence such as that caused by a crush or squeeze, the ribs generally give way about their middle and three or more become injured, both sides being not unfrequently involved. When the bones are merely broken, it is called a *simple* fracture; but when complicated with a wound communicating with the fracture, *compound*. When the ends of the broken ribs are driven inward, the pleura costalis or the lung itself may be torn and the heart or pericardium or abdominal viscera injured. In an analysis of 136 consecutive cases which I made when registrar at Guy's, 108 were uncomplicated, and of these 8 only had secondary inflammation; 28 were complicated fractures: of these 6 died at once from fatal collapse, 16 were complicated with emphysema, 3 with emphysema and hæmoptysis, and 3 with extensive injury to the lung and secondary inflammatory symptoms. Two of these cases subsequently died from old-standing disease. Fractured ribs on the right side are often complicated with laceration of the liver.

When a rib is broken, the serous lining of the chest, the pleura costalis, is probably injured, and the danger of the accident lies in the secondary inflammation—pleuritis—which may follow; and this occurred in 8 of the 108 cases just alluded to. In a case recently seen, which proved fatal from other causes, the pleura was unimpaired, but a quantity of blood was effused into the soft parts outside the pleura from laceration of an intercostal artery. When the lung is injured, as indicated by emphysema or hæmoptysis, pneumonia, which happens in about 7 out of every 22 cases, is the danger to be feared. Cases that die from fatal collapse *after* the accident generally do so from hemorrhage due to extensive laceration of the thoracic or abdominal viscera. In gunshot fractures a portion of the ribs may be detached and driven into the lung.

Simple fracture is a serious accident only in subjects who are the victims of some chronic chest affection, when from the broken ribs the patients are unable to expectorate, and asphyxia is favored.

Fractures complicated with injury to the lung are, however, more serious. When severe, they are *directly* dangerous from the shock to the system and the hemorrhage that frequently attends them, and *indirectly* so from the fact that the slightest lung wound is liable to be followed by inflammation of the lung itself or of the pleura.

Fractured ribs generally unite in about a month, and where they have not been kept quiet considerable callus may be thrown out or a false joint formed.

Diagnosis.—Pain at the seat of injury, aggravated by sternal pressure and associated with a peculiar catch in the breath of the patient and the general avoidance of anything like a full inspiration, is a somewhat characteristic symptom of a fractured rib, more especially when it shows itself at once after direct or indirect violence. At times, too, the patient will complain of a grating in the part, and on the application of the hand over the seat of injury, if the patient be made to cough, crepitus will be felt, this crepitus being caused by the friction of the ends of the broken bone. When the seat of fracture is beneath a thick layer of muscles or fat, this symptom may, however, escape detection; nor should it be too closely sought after when others indicate the nature of the injury, as the manipulation required to elicit this sign is sometimes considerable, and any approach to violence or over-manipulation is always injurious.

When **emphysema** complicates the case, as indicated by a more or less diffused puffy swelling which crackles on pressure, there will be no doubt as to the lung having been injured, since this symptom is caused by the escape of air from the lung into the cellular tissue about the seat of fracture. This may be either local or general; when associated with *hæmoptysis*, it is fair to infer that the lung has been penetrated, the severity of the mischief being gauged by the extent of the emphysema and the amount of the hæmoptysis.

In rare cases the emphysema lasts for days. In a case under care in October, 1881, it remained for seventeen days after the accident; the patient recovered.

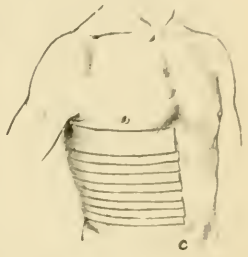
Emphysema may be met with as the result of chest injury without fracture of the ribs, as evidenced by the case of a boy æt. 5 who, having had the wheel of a cart pass across his shoulders, was admitted in 1883, within a few minutes after the accident, into my ward at Guy's with universal emphysema and such difficulty of respiration that death appeared imminent. The boy's body and neck appeared like a tight sausage. To let out the air I punctured the integuments over the child's body with a small knife an eighth of an inch wide, and the air whistled out of the openings with enough force to blow out a lighted wax taper. The relief afforded by the operation was marked, for the child steadily went on to a complete recovery. There was no hæmoptysis in this case or evidence of fracture of the ribs. The child also cried naturally, the fact fairly proving that neither the larynx nor the trachea was lacerated. Yet the opening into the air-passages must have been very

free to give rise to such rapid and general emphysema. The relief given by the operation of puncturing the skin is a point to remember (*Brit. Med. Journ.*, January 26, 1884).

Treatment.—The object of the surgeon in the treatment of a simple fracture of the thorax is to maintain the ribs at rest, which should be effected by the application of strips of strong adhesive plaster two inches broad, extending from the sternum to the spine, and from at least three inches above to three inches below the seat of injury.

The strips should be applied from below upward and at the end of expiration, and each one should be made to cover half of that which preceded it (Fig. 353). By this method the movements of the broken ribs are restrained without those of the opposite side being interfered with. It is, moreover, in both comfort and efficiency, far superior to the old method of encircling the chest with a flannel roller; indeed, it generally affords speedy relief to all symptoms. When the case is complicated with emphysema, or even with hæmoptysis, the same treatment should be carried out; for in these more severe cases the necessity of maintaining the immobility of the ribs is just as necessary as in the less severe.

Fig. 353.



Strapping in Fracture of Ribs.

In rare cases in which much displacement has occurred a sheet of felt or gutta-percha made soft by hot water and moulded to the part is of great value, the mould being subsequently fixed by strapping as described.

The patient should be kept quiet, though not necessarily in bed, and abundance of bland, nutritious, but unstimulating, food given, with sedatives if required; of the latter, chloral in half-drachm doses is probably the best, though morphia or Dover's powder is also good. When cough or any symptoms of inflammation of the pleura or lungs appear, antimonial wine in doses of thirty minims for an adult every four or six hours in some saline mixture is a most valuable remedy. When chest complications are severe and orthopnœa with a sense of suffocation from pulmonary congestion threatens life, venesection should be practised. Local treatment by itself was sufficient in 100 of the 136 cases above mentioned.

In a case of severe injury to the chest that came under my care some time ago, caused by the passage over it of the wheels of a heavily-laden cart, fracture of five or six ribs and dislocation of the clavicle occurred, associated with collapse, intense dyspnœa, and hæmoptysis; I bled the patient twice in twelve hours, and each time with immediate relief, the case going on to a good recovery. In it the severe dyspnœa and venous congestion, the rapid and hard pulse that came on as soon as the collapse of the accident had passed away and the circulation had been restored, too surely pointed to an excessive engorgement of the lungs, and indicated that if relief were not afforded absolute suffocation would speedily ensue by the patient's own highly-carbonized blood. At such a crisis antimony, however beneficial in simpler cases, could not be trusted, as there was no time for it to take effect. Under these circumstances bleeding was performed, and as the blood flowed life seemed gradually to return: the laborious breathing became quiet and subdued; the deadened and congested eye bright and natural; the pulse, from being full and hard, softer and less bounding; and the boy's feelings, released from the impression that death was nigh at hand, became more hopeful and resigned; and as a spectator I felt such a hope was valid and that success might crown our efforts. After the lapse of twelve hours, however, the symptoms returned, and the repetition of the bleeding was followed by a repetition of all its benefits. The antimony then came in to complete the cure: by the double venesection the pulmonary vessels had been relieved of their congestion, while the antimony, in acting upon the circulation, perfected the cure by preventing a return of the former threatening symptoms. The benefits arising from the treatment adopted in this case have such a lasting hold on my memory that I cannot too strongly recommend the practice thus pursued, and the more so as I have seen it equally successful in other cases.

Bleeding is now rarely performed, and at Guy's Hospital I believe it is rarer than any capital operation. In the case of lacerated lung, however, when urgent dyspnœa makes its appearance and the powers of the patient do not forbid it, I know of nothing which gives greater relief to the patient or greater satisfaction to the practitioner. Bleed with no sparing hand, letting it flow freely in a full stream, and as it flows the symptoms will gradually disappear. When relief has been obtained, arrest the flow immediately, as syncope can do only harm. The aim should be to make an impression through the sys-

temic circulation upon the pulmonary. The patient should be carefully watched and the operation repeated if the symptoms return, and if necessary even for a third time. The antimonial treatment, however, must not be neglected. The object of the bleeding is to relieve immediate symptoms and to give time for the antimony to take effect, because, when the patient has been brought fully under its influence, all danger may be said to have disappeared; few patients die from secondary inflammation of the lungs when once fairly under the influence of antimony.

Fracture of the sterno-costal cartilages is a rare accident. I have seen but few cases; in one of the seventh rib, which had resulted from a direct blow, a false joint existed. In a recent case, in which the cartilage of the right second rib was driven in by direct violence, no harm followed. These, which are said to unite generally by bone, can be treated in the same way as fractured ribs.

Dislocation and fracture of the sternum are likewise rare accidents, and the majority of them are complicated with other injuries, especially of the head and spine; they were found in 4 out of 56 fatal cases of injury to the spine at Guy's Hospital. The sternum yields, owing to the violent descent of the chin against the manubrium. Fractured sternum is also occasionally met with as a complication of fractured ribs. When fracture takes place, it is generally transverse and oblique from before backward, the lower fragment being found projecting. Only rare examples exist of a vertical fissure. When the upper portion of bone is displaced, it is generally displaced backward. Rivington in an able paper (*Med.-Chir. Trans.*, 1874) has fairly shown that displacement occurs in preference to fracture when an arthrodial joint exists between the manubrium and gladiolus.

Diagnosis.—When deformity is present from displacement of bones, the diagnosis is easy; and when this does not exist, pain in the part, aggravated by a full inspiration and crepitus on the application of the hand, is the chief symptom.

Treatment.—The treatment must be the same as for fractured ribs—namely, the recumbent position and strapping over the part, complications being dealt with as they arise. I have lately had under care a man who from a blow from the pole of a wagon had the upper two inches of the body of the sternum displaced inward from the manubrium and costal cartilages; the bones partially recovered their position in three weeks, and the man got well.

Dislocation of the ribs requires notice, although little can be said about the subject. It is rarely if ever an accident *per se;* and when it occurs, it is part of a more severe injury, such as fracture of the spine or complicated fracture of the ribs. The same remarks apply to dislocation of the *ribs from the cartilages* and of the *cartilages from the sternum*. Practically, all these cases should be dealt with like fractures.

Wounds of the Chest.

The main point to be determined in such cases as these is whether the wound is superficial or has penetrated the pleura; for if the former obtains slight cause for anxiety exists, but if the latter the accident is grave.

When the wound is *penetrating*, the extent of the penetration and the organ penetrated have to be determined. Is the pleura alone wounded—a rare injury—or is the lung involved? Is the heart injured or any of the great vessels—the intercostal or internal mammary artery? Many of these points can be determined only by a knowledge of the kind of weapon employed, its subsequent appearance, the direction of the force, and the anatomical knowledge of the surgeon; and even then the difficulties of these cases are often great, as witnessed in a recent memorable trial (Flora Davy). When emphysema and hæmoptysis are present, they may be accepted as clear indications of a wounded lung. Emphysema alone is always a suspicious symptom, though it may occur to a limited extent in non-penetrating punctured wounds that traverse the soft tissues outside the thorax; while the absence of hæmoptysis is no proof that the lung has escaped injury. When blood and air bubble through the wound and air passes freely from it or a portion of lung protrudes, there is no room for doubt as to the nature of the injury; but these cases are exceptional. In the majority the diagnosis is ever uncertain, since there are no definite individual symptoms by which injury to the lung is to be diagnosed. The surgeon in his anxiety to make out the point must never be induced to probe the wound or to explore it with a finger, nor should he test the condition of the lung by making his patient cough to expel air through the thoracic opening. Indeed, he should throw aside all direct or manipulative modes of investigation and trust to the indirect.

The *direct* effects of a penetrating wound are hemorrhage into the chest or hæmothorax, emphysema, pneumo-thorax, and hernia of the lung. The *secondary* results are those of inflammation, such as pleurisy or pneumonia, hydro-thorax, or empyema, with their consequences.

Prognosis.—The prognosis is always unfavorable and should be guarded, more particularly when the wound is penetrating; but when a week has passed without any unfavorable symptoms appearing, a more promising and decided tone may be assumed.

Treatment.—In all suspected or obvious penetrating chest wounds the utmost gentleness should be employed and complete quiet enforced, as any deviation from this practice may disturb nature's reparative process, disarrange clot, and excite overaction or inflammation. The external wound should be carefully *cleaned and closed* and all foreign bodies removed. The patient should be placed in the recumbent position and on no account allowed to stir. He should be fed on the simplest nutritious food, and for the first two or three days this should be cold; ice and milk form, without doubt, the best mixture. The collapse which often follows the injury need not excite alarm unless it be protracted or severe; for when the result of hemorrhage, it is not only a salutary measure, but the only means the surgeon looks to for the arrest of hemorrhage, as he himself is powerless to interfere. If blood, however, accumulate in the chest and by its mechanical pressure threaten life, some means must be found for its evacuation, either through the original wound or by the operation of tapping or by an incision of the thorax. The indications should be very decided before the surgeon interferes, as the extravasated blood rapidly coagulates, and consequently is difficult to remove. The same remarks hold good when air accumulates or is pent up in the pleural cavity.

The symptoms that attend reaction should be carefully watched, and anything like excess of action, as indicated by increased difficulty in respiration, cough, or a rapid pulse, ought to be met by the administration of antimony in half-drachm doses of the wine with some saline every three or four hours.

If the lungs become gorged with blood and asphyxia threatens, venesection is as valuable a remedy in these cases as it has been shown to be in those of fractured ribs. Dr. Macleod tells us that in the Crimea the cases of gunshot wounds of the chest that did the best were those in which early and repeated bleedings were had recourse to. Pain must be relieved by anodynes, chloral being better than opium.

Hernia of the lung, or pneumocele, is a rare consequence of a punctured wound of the thorax. I have seen but one example, where the tumor was on the left side, external to the nipple, and about the size of a walnut. The mass was left *in sitû* and gradually withered. When the hernia is recent, however, and the lung healthy, its reduction is generally considered to be the best practice; but when of long standing and diseased, it had better be left alone. Its removal by ligature or the knife has likewise been recommended, successful cases having been recorded of all forms of practice. In a case which came under my care at Guy's in 1876, of fracture of the sternal ends of the left third and fourth ribs by the man falling upon the blunt end of some wooden palings, in which the bones were driven in without wounding the integuments, a hernia of the lung took place the size of a duck's egg; but an excellent recovery followed the reduction of the hernia and the persistent application of pressure. Velpeau has recorded an instance of hernia of the lung following the healing of a wound. The tumor in such a case is covered with integument, and is called "the consecutive variety of hernia." In such a case all that can be done is to protect the lung from injury by a shield.

Laceration of the lung without fracture of the ribs is an accident of occasional occurrence, and I have recorded an instance in *Guy's Reports* for 1860 arising from extreme pressure upon the elastic ribs of a boy æt. 7. I saw another case in 1869, in a child æt. 4 who had been run over. The rent was on the lateral side of the right lung and ran from its apex to base. The ribs of the same side were broken at their angles far behind the seat of rupture. Poland also, in his excellent article on the chest in *Holmes's Surgery*, has quoted several others. M. Gosselin's explanation of its cause is probably correct—viz., "that at the time of the injury when the chest sustains the violence, the lungs are suddenly filled and distended with air by a full inspiration, and the air, prevented from escaping by occlusion of the larynx, thus becomes pent up in the lung tissue, and, the lung not being able to recede from the superincumbent pressure, its tissue necessarily gives way." The symptoms of this injury are much the same as have been mentioned in the paragraph on wounds of the lung, while the treatment must be similar.

Severe compression of the chest may likewise cause laceration of the heart

or large vessels; also brain symptoms, such as unconsciousness, epistaxis, and hemorrhage into the orbit beneath the conjunctiva and eyelids; and in a singular case which I recorded in the same volume of the *Guy's Rep.* as that of the boy just quoted paralysis of the muscles of deglutition and of the larynx, which lasted for two days.

Abscesses are frequently found about the chest, and in rare instances may be due to the discharge through the lung of a foreign body. Thus Dr. Wilks recorded at the Pathological Society on November 1, 1881, a case of a child in which an ear of corn was discharged from an abscess situated in the left suprascapular region. A recovery followed. No history could be obtained as to how the foreign body entered the lung. It was probably inhaled.

When abscesses are situated beneath the pectoral muscles, they are very obstinate. They may be confined to the cellular tissue of the part and connected with the subpectoral glands or associated with ruptured muscle or inflammation of the periosteum or bone.

When connected with the muscles, they must be opened and the parts kept quiet by binding the arm to which the muscle belongs to the side, as each movement of the muscle retards recovery.

When due to *periostitis* or *ostitis*, they are frequently syphilitic, and are more commonly situated over the sternum, though any of the ribs may be affected. Under these circumstances constitutional treatment is essential, and the iodide of potassium, in gradually-increasing doses, from five to ten grains, in some tonic such as bark, is the best medicine. If the bone dies (necrosis), the dead portion must be removed when nature proves herself incompetent to throw off the *sequestrum*.

When sinuses exist about the thorax, the surgeon should always be alive to the fact that they may be due either to an *empyema* which has naturally discharged itself or to a *substernal abscess*, which is making its way through the intercostal spaces. The history of the case will be found to be the only correct clue to the diagnosis. In both instances a free opening into the abscess and the washing out of its cavity are required.

Tumors of the chest are not uncommon, but come more under the notice of the physician. Malignant and other tumors, however, may arise external to the ribs; and I have seen several cases of exostosis from the ribs, and one of enchondroma. No surgical interference was called for. Exostosis from the first rib may press upon the branches of the brachial plexus and give rise to some pain, or upon the subclavian artery or vein and produce obstruction. In some cases these exostoses have been removed.

Deformities of the chest are mostly due to spinal curvatures, though the contracted or compressed thorax with the projecting sternum of childhood (pigeon-breast) is frequently found where some long-continued obstruction to natural respiration, such as enlarged tonsils, exists. This is not, however, permanent in a large number of cases, since children who are the subjects of it "grow out" of the deformity; as their general condition improves the cause is removed and their powers strengthen. It is commonly found in rickety subjects, and is, without doubt, occasionally the result of enlarged tonsils.

Deformity of the chest may be due to an old pleurisy.

Tapping the Chest.

When air accumulates in the chest (*pneumo-thorax*) as a consequence of either disease or accident, causes pressure on the lung, and interferes with the respiratory process so as to create alarm, the tapping of the chest (paracentesis thoracis) with a small trocar and canula fitted with a valve may be called for. When blood accumulates (*hæmo-thorax*), producing similar alarming symptoms, and the blood is mixed with air, and it is clear that life will be extinguished if relief be not afforded, the blood and air must be let out; and for this purpose it is probably the best operation to make an incision into the thorax where no wound previously existed, or to enlarge a small wound when present. To give relief with a trocar and canula is always a difficult, and often an impossible, task, on account of the coagulum. When *serum* presses upon the thoracic contents (*hydro-thorax*) and requires surgical interference, the trocar and canula with the aspirator are beyond doubt the best instruments to employ, great care being observed to exclude air. The object under all these circumstances is to remove the pressure from the lung in the most effectual way by the withdrawal of the compressing material. When pus exists (*empyema*), surgeons are not quite decided as to the best means to be employed, although all are agreed as to the propriety of drawing it off. A generalized empyema rarely points externally; a localized one does so frequently. For diagnostic purposes the aspirator may be a valuable instrument, as it is for the first emptying of a localized empyema; but for

a general empyema the practice of aspirating is not to be advocated, since nothing less than free drainage is likely to succeed, as a general rule. To tap by means of the aspirator or the trocar and canula gives temporary relief, but does not cure the disease, for which more efficient measures are required. For my own part, I believe that when pus so presses upon the lungs and interferes with the respiratory process as to call for surgical interference the pus must be let out by means of a free opening, the opening being large enough to permit of the free escape of all fluid through a drainage-tube. The introduction of drainage-tubes by M. Chassaignac has been of great service in the treatment of empyema. Dr. Goodfellow and Mr. de Morgan—early advocates of their use in this country—passed the perforated india-rubber tube through the canula upon a long iron probe, and brought it out of a second opening in the lower and posterior part of the chest, this second opening being made with a scalpel upon the extremity of the probe pressed against the lower intercostal space. The perforated tube consequently passed as a seton through the chest and allowed the free escape of any fluid in its cavity.

I have never adopted this practice in the way here detailed, being satisfied with a free opening into the thorax, with either a scalpel or a large trocar and canula, and the introduction of a drainage-tube into the thorax either through the canula or otherwise and the subsequent daily washing out of the cavity with a solution of iodine. Subaqueous drainage may be employed. In May, 1875, I followed the former practice in the case of a gentleman æt. 37 whom I saw with Dr. Rowlands of Carmarthen, and drew off three quarts of pus from his left chest through a free opening, and subsequently passed a drainage-tube into the cavity. In three months convalescence ensued, and in another month he was quite well, the lung on the affected side having expanded. Indeed, I quite coincide with Dr. Goodhart (*Guy's Hosp. Rep.*, 1877) that "if drainage is decided upon, nothing short of perfect drainage is safe for the patient;" and to this end the opening into the thorax must be free and the cavity of the chest kept well emptied, either by irrigation or by what has been described as subaqueous drainage, which should be carried out as follows: "Having determined on the spot at which puncture of the chest is to be made, a trocar and canula are taken, the bore of which is about five millimètres. A length of several feet of black or red india-rubber tubing which will slip easily through the canula is placed ready at hand: the chest is then tapped and the trochar withdrawn, and as the fluid comes in full stream by the canula the india-rubber tubing is pushed along the latter into the chest as far as necessary—usually four or five inches. The canula is then withdrawn over the tube, leaving the one end of the latter in the chest, while the other or free end is kept under water by the side of the bed. The tube then acts as a syphon."

This plan of drainage is not, however, very complete; for out of 30 cases in which it was employed, as reported by Dr. Goodhart, in 18 imperfect drainage had to be recorded, and, as this is a method which professes to drain away pus, it cannot be said to have proved successful.

In young people, where the ribs are elastic, good results may be looked for: but in the old, where the ribs are rigid, no contraction can be expected.

The Operation.

In tapping the chest for air, serum, or pus the following points should be observed: Where the signs of disease are most marked, there the puncture should be made. When the chest is full of fluid, the eighth or ninth intercostal space should be chosen, just in front of the angle, or the seventh, midway between the sternum and spine. This latter spot can always readily be found by drawing a line with a string round the body on the level of the nipple, and midway between the sternum and spine this line will cut the proper intercostal space. At this spot, close to the lower rib, a small incision should be made through the skin and fascia with a lancet or scalpel, and through this the trocar and canula, warmed and oiled, should be introduced; the trocar, as soon as it has perforated the chest, should be withdrawn, the canula being pushed more home. When the operation has been performed for air or serum, a small instrument should be employed and great care used to prevent the admission of air. For this purpose there is no better instrument than the pneumatic aspirator of Dr. Dieulafoy or one of its modifications, and Dr. Bowditch of Boston, United States—a staunch supporter of this practice—reports (*Practitioner*, April, 1873) that during twenty-four years and in 270 operations he had never seen any injury done by the aspirator. As a substitute one of the canulas may be used fitted with a stop-cock or valve, to prevent the admission of air.

When the chest requires opening for the discharge of blood or pus, a free incision or large canula should be resorted to. I prefer an incision, and make it large enough to admit my little finger, and subsequently a large india-rubber drainage-tube. Trousseau strongly advises the operation of tapping when serous effusion fills the cavity, as indicated by auscultation and percussion; when oppression of breathing also exists, it may be urgently needed; but this oppression, adds he, is one of the most deceitful of signs, and its absence ought not to inspire too great a feeling of security, as by refraining from interference we run the risk of losing patients whom the operation would assuredly have saved. In empyema he fixes in the canula and draws off the fluid every twenty-four hours, injecting the chest with a solution of iodine, one part of the tincture in six, every two, three, or four days.

It should, however, be recorded that sudden death has taken place after thoracentesis for pleuritic effusion or empyema, although evidence is wanting to prove that any distinct relation exists between the operation and death, since cases are on record in which sudden death ensued in the normal course of cases of pleuritic effusion. Trousseau has recorded examples of the latter kind, and Drs. Cayley and Broadbent of the former (*Clin. Society*, 1877).

Apnœa, or so-called Asphyxia.

Death from asphyxia, in the common acceptation of the term, means death from either the cessation of the respiratory process or the want of the ordinary respiratory medium (oxygen), the heart ceasing to act after the cessation of the respiratory process. Etymologically, it means an absence of pulse. The more correct term is "apnœa." It is caused by whatever interferes with the admission of the air into the lung—by such acts as *drowning* and *hanging*, by diseases that mechanically block up the air-passages or excite spasm of the larynx, by any external or internal condition of the thorax that prevents the admission of air into its cavity or interferes with its expansion, by the want of the respiratory medium, or by the inhalation of toxic vapors.

Under some circumstances the asphyxia is rapid or acute; in others, chronic. In accidental cases it is chiefly the former; in disease, the latter. In both, however, the result is the same, the blood not being decarbonized as it should be, and what Dr. Cleveland has rightly called carbonæmia ensuing. Special symptoms may depend entirely upon the nature of the asphyxiating cause, but the ultimate effects are the same in each. In all, whether slow or rapid, there are congestion and lividity of the face. In all the heart continues to beat, though laboriously, after respiration has ceased, the action becoming gradually less distinct, till it stops altogether. It is possible for the heart to continue its action from two to four minutes after the last respiratory effort.

After death, it has generally been thought the *cerebral vessels* would be found gorged with blood. Ackeman has shown, however, that this condition is present only when the head of the subject has been kept lower than the rest of the body, and that death by suffocation is always connected with an exsanguine state of the cerebral vessels. The *right side of the heart and great vessels* will be full of black blood, whilst the *left* side will be found empty; and the whole arterial blood will be, as the venous, of a dark color. All the abdominal viscera will be engorged with blood.

The *lungs*, in cases of hanging and mechanical obstruction, present no characteristic appearance, but in those of drowning they will be more or less filled with water or the drowning medium and incapable of collapsing, and will feel heavy and doughy to the touch. The air-tubes, moreover, will be choked with a sanious foam composed of blood, water, mucus, and often foreign matter churned up with the air of the lungs. Frothy water mixed with blood will also pour out of any section of the lung. These points were clearly stated by the committee of the Roy. Med. and Chir. Society on suspending animation, and recorded in the *Transactions* for 1862.

Drowning.

How long a human being may be under water and yet recover is an important question, but the answer depends upon many considerations. Dr. Sanderson believes he has demonstrated by experiments that in animals the duration of life turns upon the amount of air confined in the chest at the time of immersion—that when the animal on immersion fills its chest with water by an inspiratory effort, death is most rapid; but if the chest be full of air at the time, and no such inspiratory effort takes place, life may be prolonged for several minutes. The occurrence of syncope at the moment of immersion, whether from

fright, shock, or previous injury, is consequently a happy accident, the respiratory act being materially diminished by the syncope. "If a person be completely submerged," writes Dr. W. G. Harley in *Holmes's System*, "and the entrance of water to, and exit of air from, the lungs not prevented, we believe that recovery would be impossible after two minutes. On the other hand, if the air-passages were closed against the entrance of water and the chest kept full of air, we see no reason for thinking that a human being would perish either more slowly or more quickly than a dog placed under similar circumstances—namely, in from four to five minutes."

Death by *strangulation* is due to asphyxia alone, and, as a rule, is homicidal, being consequently often complicated with other injuries.

Death by *hanging* is of a mixed form, since, in addition to the strangulation by the cord, there is the added traction on it by the weight of the falling body.

Hanging causes death, according to Dr. A. Taylor, "commonly from apnœa, but sometimes from apoplexy, caused by pressure on the jugular vein, being preceded by convulsions, often lasting for many minutes, but in all probability not accompanied by more than momentary pain. Occasionally there is found displacement or fracture of the first or second of the vertebræ, with compression of the spinal marrow. This cause of death is only likely to be observed in corpulent or heavy persons, when a long fall is allowed by the cord, and is seldom met with in judicial executions." This latter fact is supported by the observations of Dr. Barker of Melbourne, who informed Professor Haughton of Dublin that in fifty-four post-mortem examinations of criminals hanged according to the old or "short-drop" system, in not a single case was there dislocation or fracture of the neck. In the following plan, however, introduced by Dr. Barker, this dislocation was the rule. Dr. Haughton quotes his words (*Med. Times and Gaz.*, June 21, 1871): "I have the knot put about two inches from the spine, so that when it is tightened by the weight of the body the knot comes on the vertebræ; by the fall the body has an impetus forward, the resistance being at the beam to which the rope is fastened. The knot acts as a fulcrum to push the head forward. By this arrangement I have found in all cases there was a dislocation and fracture of the cervical spine and pressure on the cord, laceration of the muscles of the larynx, and generally fracture of the hyoid bone, death being always sudden and complete; no long drop is required." To the Irish and American long-drop system there are grave objections. When the cord is crushed, death is instantaneous; when not so injured, life may be prolonged for some minutes—usually about three; but there is no evidence to believe that the period may be extended to ten. Conscious life, under both circumstances, probably is soon lost, rarely extending beyond the *three* minutes.

When the cord is not injured, Taylor computes that life may be restored after five minutes of suspension, and Tardieu, an eminent French writer, gives a similar period.

Treatment of Apnœa, or Asphyxia.

All obstruction to the passage of fresh air to and from the lungs is to be at once, so far as practicable, removed, all froth and mucus to be cleansed from the mouth and nostrils, and all tight articles of clothing to be at once taken away from the neck and chest. In slight cases of temporary apnœa the treatment is as in syncope, dropping the head, which should be low in all cases, a dash of cold, or alternately of cold and hot, water to the face, or a smarting slap upon the epigastrium, generally sufficing to revive the patient. When this proves useless, artificial respiration should be instantly commenced.

Fig. 354.

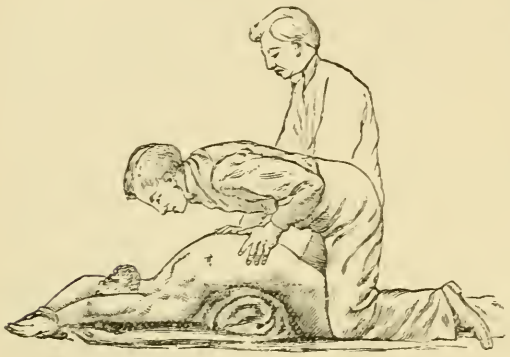
The methods of artificial respiration which have been successively in use are those of the late Drs. Marshall Hall and Silvester, but I believe the best method to be the one more recently advocated by Dr. Benjamin Howard of New York. This "direct method," as the author calls it, was first published in the form of a prize essay by the American Medical Association in 1871, and has since been adopted by the United

States Government Life-Saving Service, the Life-Saving Society of New York, etc. It is eminently simple and effective, and is to be applied in the treatment of the drowned as follows, the rules having been drawn up for me by Dr. Howard:

Rule 1. For Ejection and Drainage of Fluids, etc. from the Stomach and Lungs. *Position of Patient.*—Face downward with forehead resting upon the fore-arm or wrist, to keep the mouth from the ground, and a hard roll of clothing beneath the epigastrium, which should be the highest point, while the mouth is the lowest (Fig. 354).

Position and Action of Operator.—With the left hand well spread out upon the base of the thorax, to the left of the spine, and the right hand upon the spine, a little above the left and over the lower part of the stomach, the operator should with a forward motion throw upon them all the weight and force the age and sex of the patient will justify, ending this pressure of two or three seconds with a sharp push, which helps to jerk him back to the upright position. And this movement should be repeated two or three times, according to the period of submersion and other indications.

Fig. 355.



Artificial Respiration by Direct Method.

Rule 2. *Position of Operator.*—In a kneeling posture, astride patient's hips; his hands upon the chest, so that the ball of each thumb and little finger rests upon the inner margin of the free border of the costal cartilages, the tip of each thumb near or upon the zyphoid, and the fingers fitting into the corresponding intercostal spaces; the elbows firmly fixed, making them one with the sides and hips; then—To Perform Artificial Respiration. *Position of Patient.* Rip or strip clothing from the waist and neck. Face upward; shoulders slightly declining over. Hard roll of clothing placed beneath thorax; the head and neck bent back to the utmost, with the hands on the top of the head (one twist of handkerchief around the crossed wrists keeping them there) (Fig. 355).

The operator, pressing upward and inward toward the diaphragm, using his knees as a pivot and throwing his weight slowly forward two or three seconds until his face almost touches that of the patient, should end with a sharp push, which helps to jerk him back to the erect kneeling position. He should then rest three seconds and repeat this bellows-blowing movement as before, continuing it at the rate of seven to ten times a minute, taking the utmost care, on the occurrence of a natural gasp, gently to aid and deepen it into a long breath until respiration becomes natural. When practicable, the tongue should be held firmly out of one corner of the mouth with the thumb and forefinger armed with dry cotton rag.

Avoid all impatient vertical pushes; the force upward and inward must be increased gradually from zero to the maximum the age, sex, etc., may indicate. Abandon no case as hopeless within an hour's useless effort.

In the application of this method to cases of stillbirth the child lies along the left hand of the operator, the ball of whose thumb takes the place of the hard roll of clothing seen in Fig. 355. Over this the shoulders decline, the head falling back, with the arms, if convenient, on either side the face. The buttocks and thighs are supported by the operator's fingers.

Thus the operator has the prominent little thorax completely within the grasp of his right hand with firm counter-pressure behind, enabling him to apply, locate, distribute, direct, or alternate his pressure as he pleases.

The advantages Dr. Howard claims for this method over other methods are: 1st. It provides for ejection and drainage of fluids, etc. from the stomach and lungs, and in such a way that each motion for ejection induces an alternate inspiration. 2d. It excludes the tongue from the pharynx without manipulation. 3d. It secures elevation of the epiglottis and a post-oral air-way from the glottis to the nares. 4th. It includes a remedy against syncope and cerebral anæmia. 5th. It obtains a more general expansion of the thorax. 6th. It effects a thoracic compression which is more complete, better distributed, directed, and regulated. 7th. It is done by one person and can be applied instantly on

the spot wherever the patient is found. 8th. It is more easily understood by the illiterate, is less fatiguing to the operator, and is free from unnecessary motion or violence.

When respiration is re-established, maintain the temperature of the body by friction, warm blankets, and when possible by warm water (106° F.) or air bath, keeping the head where a circulation of pure air may be maintained. As soon as the patient can swallow give warm milk, beef tea, tea, or coffee, with a tablespoonful of some spirit; or these may be injected by the stomach-pump. When respiration is restored, put the patient into a warm bed with hot bottles to his feet and encourage sleep, but let him be watched in case of secondary or relapsing apnœa; at the slightest symptoms of which, let friction, and even artificial respiration, be re-employed. Give volatile stimulants, such as the spiritus ammoniæ aromaticus.

SURGERY OF THE URINO-GENITAL SYSTEM.

CHAPTER XX.

DISEASES OF THE KIDNEY.—STONE.—NEPHROTOMY.

Malformations of the kidney have more scientific than surgical interest, yet they may have an important surgical bearing; for when any accident from external violence or internal irritation happens to a single or imperfect organ, the life of a patient is more likely to be jeopardized than when it is normal. In a case recorded on page 489 this fact was illustrated. When a kidney is single, it is usually large and sometimes has the form of a horseshoe; when it assumes a central position, with the convexity of the curve downward, it may be regarded as a double organ, the vessels entering from above in their normal way. A kidney may also hold a position nearer the pelvis, or even lie in the pelvis; it may be "movable" or "floating." At times the adult kidney maintains the lobulated character it possessed in fœtal life. A kidney when loosely connected may appear as a movable abdominal tumor, and in exceptional cases be the seat of much distress. In such operative surgery may be required. (*Vide* "Nephrorraphy," page 631.)

The diseases of the kidney are generally regarded as belonging to the physician, but I need hardly add that a thorough knowledge of renal pathology is as requisite to the surgeon as it is to the medical practitioner, for without such a knowledge he will be able neither to recognize the different conditions of the urine with its deposits nor to appreciate their significance. He will likewise be as unfit to decide upon the propriety of an operation of expediency as to understand the risks of one of necessity; for the existence of kidney disease, as a rule, is enough to debar the surgeon from performing any operation other than that required to save life, and in such operations it renders the prognosis most unfavorable, since kidney disease is well known to be the chief cause of death after operations.

As a rule of practice the condition of the kidney, as expressed by the character of the urine, should be made out in all cases in which an operation is thought of, and more particularly in operations upon the urinary organs.

Nephritis.

Inflammation of the kidney associated with suppuration of the organ has long been recognized as a common consequence of obstructive disease of the urinary passages. But it may occur as a consequence of local injury, or as an acute attack upon a chronically diseased organ, or as a consequence of pyæmia or other cause. It is also very common as a sequel to Bright's disease of the kidney—that is, to disease of the secreting structure of the organ—in consequence of some local source of irritation in any part of the urinary passages. Bright's disease by itself is not a suppurative disease.

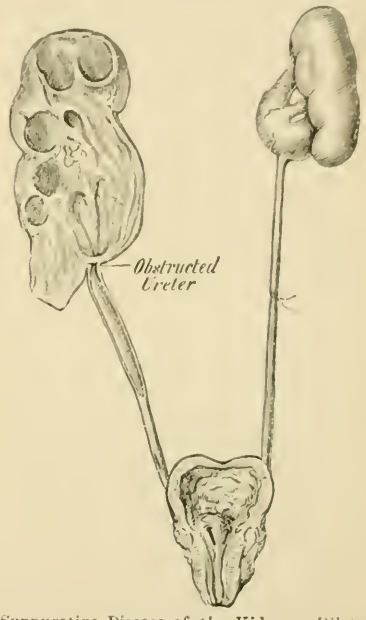
Suppurative nephritis may occur as an *acute* or as a *chronic* affection, though more frequently as an *acute upon a chronic* disease. After death a kidney thus affected may appear enlarged, with its substance more or less filled with suppurating cavities. When the inflammatory action is confined to the mucous lining of the pelvis of the organ, it is called *pyelitis*. At times the kidney is a mere cyst or shell containing pus and broken-down tissue, and in extreme cases the kidney and parts around form one large suppurating cavity. This condition is not rare as a consequence of the breaking up of tuberculous matter, and then it is usually symmetrical.

Symptoms and Diagnosis.—When after an injury in the loins, or in the course of some obstructive vesical, urethral, or calculous affection, a patient is seized with rigors,

severe pain and tenderness in the lumbar region, febrile disturbance, nausea, vomiting, scanty, high-colored, and possibly bloody, urine, and irritable bladder, *acute nephritis* may be suspected. When rigors recur frequently and there is suppression of urine with renal casts or pus in the urine, suppuration of the organ is to be diagnosed; and when to these symptoms are added severe depression, anasarca, and brain symptoms passing on to coma, uræmic poisoning may safely be expected.

But **chronic nephritis** is a more common affection than the acute; indeed, unless from accident, the acute is generally a sequel to the chronic. Kidney disease is a common consequence of long standing or neglected bladder or urethral mischief. When a stone has existed for any period in the bladder and has set up inflammation of that organ, when from prostatic disease the same result ensues, or when from stricture the urinary organs have been subjected to irritation and distension from retained urine, the ureters, and later on the pelvis of the kidney, and subsequently the secreting structures of the kidneys themselves, become inflamed by extension from the bladder. Under these circumstances every gradation of dilatation, inflammation, or suppuration of the whole urinary passages may be found; the bladder may be enormously thickened and inflamed; the ureters dilated, tortuous, thickened, and suppurating; the pelvis of the kidney expanded and filled with pus—*pyelitis*—and the kidney itself more or less undergoing disorganizing changes (Fig. 356).

Fig. 356.



Suppurative Disease of the Kidneys, Dilatation of Ureters, Hypertrophy of the Bladder, etc., the effect of Urethral Obstruction. (Drawing 368[85], Guy's Hosp. Mus.)

Symptoms.—The symptoms of changes such as these are not very definite. In all *long standing* examples of obstructive urinary affections some of them may be suspected; so also in all cases of neglected stone, particularly when bladder symptoms are marked; in cases in which the urine is albuminous, pale-colored, and smoky, or tinged with blood; when it contains pus in suspension, varying in quantity at different times, or shreds of lymph; when a dull, aching pain is present in the loins, shooting round the hips into the groin and down to the testicles; when vomiting is constant and persistent, and the digestive organs do their work badly; and when sleep is difficult to secure or superseded by a general drowsiness.

Diagnosis.—Under these circumstances chronic kidney disease may fairly be diagnosed, with or without suppuration in the organ or around it.

When anasarca sets in or brain symptoms from uræmic poisoning appear, the diagnosis is clear.

When rigors are frequent, even when not well marked, when lumbar pain is constant and increased on pressure, when on manipulation evidence exists of some deep-seated lumbar swelling and fluctuation is distinctly or indistinctly to be made out, *abscess of the kidney* is fairly indicated. When with these a sudden discharge in the urine of large quantities of pus takes place with relief to the local symptoms, it is probable that the abscess has discharged itself through the ureter; when the lumbar pain becomes more intense, the swelling more marked and prominent, and fluctuation more distinct, it is probable that the ureter has become obstructed and the renal abscess is making its way through the loin externally; and many cases are on record in which, after the discharge of the abscess by natural or surgical means, a recovery has ensued. Indeed, stones have been taken away from or discharged from the kidney in this way with a good result.

Renal, like perirenal, abscesses are, however, prone to make their way through the diaphragm into the lung or into the colon; and cases are recorded where they burrowed downward and appeared below Poupart's ligament or in the pelvis. In these cases the symptoms simulate spinal disease, the thigh being flexed upon the pelvis, this symptom attended with lumbar pain or tenderness, being very constant in nephritic as in perinephritic abscess. Dr. Bowditch of Boston was the first to draw attention to the fact in 1869 and 1870.

Treatment.—When acute nephritis originates from a blow or from the irritation of a renal calculus, complete rest in the horizontal posture in a warm bed is absolutely essential, with *milk diet* and the moderate use of simple diluents, as milk and water or barley water. Poppy fomentations to the loins always give comfort, and when the pain is severe leeching is beneficial; cupping has been recommended and is of use. The bowels should always be well cleared out by some simple medicine, such as castor oil or an enema. All medicines that act upon the kidney, as salines or turpentine, all external applications, such as blisters, should be carefully avoided; and for this same reason stimulants ought not to be given.

The action of the skin should be encouraged by outside warmth, and the hot-air bath or steam bath, applied to the patient in bed, is a valuable means to this end; a hot bath is a good substitute. Calomel and antimony cannot be recommended.

When the case passes into the chronic stage, counter-irritation becomes of value, and, as this cannot be obtained by means of blisters, since cantharides act powerfully on the kidneys, mustard may be employed, or a piece of lint saturated with a mixture of chloroform and alcohol should be applied to the loin and covered with oil silk. Dry cupping also is of great value.

When *acute nephritis* supervenes upon the chronic form, the result of long-standing disease of the urinary organs, or after operation, the whole aim of practice must be to soothe, relieve pain, and keep life going. Nothing like mechanical interference with the urinary passages must be thought of. Retention of urine should, of course, be relieved, but the utmost gentleness ought to be employed in the manipulation. These cases are, as a rule, very hopeless.

In *chronic nephritis* the result of local disease there can be little doubt that the best practice is the removal of the cause. When a stone in the bladder has set up the mischief, it should be removed, and by that mode which induces the least local irritation. When a stricture of the urethra has been the cause, it should be dilated, for as long as the local cause of the disease exists no recovery can be looked for. When calculus in the kidney is the local irritant, the surgeon's aim must be to allay local irritation by keeping the patient quiet and administering soothing remedies, the alkaline potash salts being prescribed where the urine indicates uric-acid calculus, and the mineral acids when the urine is phosphatic. The removal of the stone by operation may also be entertained. (*Vide* "Nephro-Lithotomy," p. 628.)

When suppuration of the kidney takes place, with or without a calculus, and any external evidence of the abscess exists, the kidney should be cut down upon by a lumbar incision, the abscess freely opened and drained after irrigation. (*Vide* "Nephrotomy," p. 628.)

When the urine is full of pus, the preparations of buchu are of undoubted value, and the mineral acids or the preparations of iron of use. Warm baths and diaphoretics, to induce free action of the skin, and by these means to relieve the kidney, with a supply of simple nutritious food, and stimulants only when absolutely required, make up the treatment.

Perinephritis is an affection that must be recognized, and, although it may be more frequently found in connection with suppuration of the kidney, it is at times independent of it. It is indicated by a sudden pain in the loin, fever, and subsequently *lumbar swelling*, with frequently œdema of the integuments of the loin. The pain is at times constant and persistent, while at others it may appear and then disappear for an uncertain interval, to recur spontaneously in all its severity. The urine in an uncomplicated case is generally natural, and if at all altered scanty, renal symptoms, so called, being absent. When the case is left to nature, the inflammation may attack the chest and induce a fatal pleurisy, or the abscess may burst into the bowel or externally, burrowing beneath the fascia covering the psoas muscle and showing itself in the thigh or pointing to the loin. The surgeon should not, however, leave these cases to nature, but cut down upon the abscess or lumbar swelling, as in colotomy, at the outer border of the quadratus lumborum muscle, and evacuate the pus as soon as sufficient evidence exists of its presence; from this treatment a good result may be looked for. (*Vide* paper by Dr. Bowditch, *Am. Journ. of Med. Science*, 1871.)

Hæmaturia

is a symptom met with in many diverse conditions, the hemorrhage being limited or profuse. It may come from one or both the kidneys or any other part of the urinary

passage, either as a result of some constitutional cause, such as the hemorrhagic diathesis, or some morbid condition of the blood, as in purpura, scurvy, smallpox, the plague, or fever. It may likewise be parasitic. Profuse renal hæmaturia takes place occasionally as an intermittent affection. It may likewise follow an injury or disease of the kidney, ureter, bladder, prostate, vas deferens, or urethra. In surgical practice the hemorrhage is more frequently due to some local cause, yet the practitioner should be alive to the fact that it may originate from a constitutional one or from the use of such drugs as turpentine or cantharides.

Renal Hemorrhage.—If the hemorrhage follow an accident, the diagnosis is seldom difficult; for when, after an injury to the loin, blood is passed mixed with the urine, it may be inferred that the kidney has been injured; and when slender, cylindrical, pale pieces of fibrin are seen in the urine, the surgeon may be sure that they come from the kidney, these clots having been moulded in the ureter and washed down from the kidney by the urine. Blood also, when intimately mixed with the urine, has probably a renal origin.

The passage of a stone down the ureter is also attended by hemorrhage, which is rarely profuse, and is, moreover, generally accompanied by severe colicky pain shooting down the groin and scrotum of the affected side, with a retracted testicle. When blood comes from a diseased kidney, it is mixed with the urine, as in cases of accident, and may be slight or profuse in quantity; but the nature of the affection or its being due to calculus will have to be determined by the history of the case, the existence of lumbar pain or tenderness, and a close examination of the urine. In cancer of the kidney pain rarely extends to the testicle.

Parasitic Hæmaturia.—This is common in Egypt, Syria, and at the Cape, and is now known to be due to the presence of a parasite first discovered by Bilharz in 1851. Dr. Zancarol of Alexandria describes it as "Bilharzia hæmatobia." The disease is found only in weakly subjects and those who drink foul water or the undistilled water of the Nile. Its early symptoms are the appearance of blood at the end of micturition, its passage being accompanied and followed by pain, frequent micturition, and anæmia. With the parasite there is cystitis, which will go on, and at last give rise to dilated ureters and diseased kidneys.

Dr. Zancarol ascribes the frequency of stone in the bladder in Egypt to the presence of the parasite.

The urine of patients the subjects of this disease contains blood and mucus, but is of normal specific gravity. The ova of the parasite itself are to be found in it in an active condition for twenty-four hours after it has been passed. They are ovoid in shape, ciliated, and $\frac{1}{150}$ of an inch in diameter. The worm itself never passes with the urine. It is filiform and three or four lines in length. A full description of the worm may be found in the *Trans. of the Path. Soc.*, December 9, 1882.

Little can be said about treatment beyond that Dr. Wastobet of Beyrout, Syria, records (*Lancet*, December 9, 1882) a case cured by one-drachm doses of the oil of turpentine in milk three times a day in twenty-four days.

Vesical or prostatic hemorrhage, either from injury or disease, chiefly shows itself as blood clots mixed with the urine, the former passing either before or after the latter. The blood at first may fill the bladder, but after some days the urine will only be stained with blood. When the clot has broken up, more or less discolored irregular coagula with fimbriated edges will pass with the urine, these coagula being very characteristic of blood clot. They may pass *per urethram* as rolled-up masses, but when floated out in water will present their natural shape; blood that has been retained within the bladder for any time will impart to the urine a porter-like aspect.

When blood flows at the end of micturition in small quantities, squeezed out, as it were, by the bladder, a calculus or prostatic disease may be suspected; but the same condition is also occasionally met with in the irritable bladder of gonorrhœa or after the passage of "gravel."

When a cancer of the bladder or prostate or a villous growth exists, pieces of broken-up tissue may be detected by the microscope in the bloody urine. In these cases, too, the hæmaturia will be intermittent.

Urethral Hemorrhage.—When, after an injury to the perinæum or pelvis or a sudden muscular strain, pure blood flows from the urethra unmixed with urine, urethral mischief may be suspected.

Urethral hemorrhage irrespective of injury may proceed from a chancre, acute gonorrhœa, or an impacted stone. It may follow over-exertion or the straining associated with

the retention of urine or sexual intercourse. It may likewise take place after the forcible bending of an erect penis in a chordee or during some sudden muscular exertion from a rupture of the vas deferens, as pointed out by Hilton, and in rare cases it may occur without any known cause, the blood flowing from the penis unaccompanied by any symptom of disease. I have recorded two such cases (*Clin. Surg.*, Chapter 47).

Urethral hemorrhage as a result of catheterism is also common, and it may be caused by the introduction of some foreign body into the urethra.

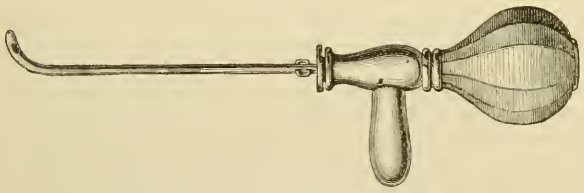
It should also be remembered that bile when concentrated, indigo, or other rare constituents of the urine, from diet or otherwise, may simulate the presence of blood, as may the black urine which results from the external or internal use of carbolic acid when absorbed in poisonous doses. This symptom, however, soon disappears on the omission of the remedy. In a case under my care in 1871, of a man who had a weak sore the size of a crown piece, which had been dressed with an oily lotion of carbolic acid one part to forty, the black urine appeared after the second dressing associated with brain symptoms and collapse of the general powers which I thought must prove fatal. The symptoms, however, speedily disappeared on withdrawing the drug, and a recovery ensued. In a case under my care five years ago a boy æt. 9 was unintentionally kept in a semicomatose state for two months by the application of a lotion of carbolic acid (one part to a hundred) to a small sore, the brain recovering its healthy condition on the omission of the lotion. The poisonous action of the carbolic acid was detected through the urine, which was occasionally black.

Treatment.—The disease or condition that gives rise to the blood in the urine requires treatment more than the symptom itself, but at times the bleeding is so profuse as to threaten life. Renal hemorrhage, when profuse, may be checked by gallic acid in full doses, gr. v to gr. x, three times a day, acetate of lead, tincture of ergot, or matico, opium being generally a valuable addition, and in extreme cases the spirit of turpentine, absolute rest in the horizontal position, and cold milk diet should be also adopted.

Hemorrhage from the bladder, when persistent, may be checked by the application of a bag of ice over the pubes and to the perinæum, by cold or astringent injections into the rectum, with rest and opium. There is no necessity to pass a catheter or to interfere with the clot so long as the urine flows and retention does not occur, the urine at the natural temperature of the body being a good blood solvent. A clot of blood, when bathed with urine, as a rule, disintegrates in the course of a few days, when it may be passed without help. Any disturbance of the clot when first formed will probably tend rather to encourage than to stop bleeding; consequently, no unnecessary catheterism should be employed.

When retention exists, the symptoms become urgent, and opium administered either by the mouth or, what is preferable, by the rectum fails to give relief, the passage of a large-sized catheter and the use of an exhausting syringe, such as Clover invented for use after lithotrity (Fig. 357), or the aspirator may be called for; yet these measures should be employed only when an absolute necessity exists and opium in full doses fails to give relief.

Fig. 357.



Clover's Syringe, as Improved by Maunder.

Urethral hemorrhage rarely continues for any time or requires for its treatment more than rest in the horizontal posture, unless caused by some laceration of the urethra or more severe injury.

Suppression of Urine

is the result of renal disease, from which, the kidneys ceasing to fulfil their functions, the constituents of the urine are left in the blood and give rise to coma, and possibly to convulsions and death. Uræmia or uræmic poisoning is then said to be the cause of death. It may occur at any stage of kidney disease, and not uncommonly follows an operation performed on a patient the subject of such an affection; it is a result to be taken into calculation before undertaking any operation where albuminous urine exists.

In exceptional cases, however, suppression of urine occurs when no such chronic mischief can be detected, coming on suddenly, as it often does, without cause, and leaving as suddenly without any reason. I once saw a musician who secreted no urine for sixty

hours, and then passed what seemed to be a natural quantity; his only other symptoms were those of slight feverishness and headache. In such cases the hot-air, vapor, or warm bath is the best remedy.

Stone in the Kidney

is not an uncommon affection, and is generally painful and often fatal. At times, however, large stones are found in the kidney after death which gave no signs of their existence during life. When the stone becomes impacted in the organ and ceases to be movable, it does not give rise to any marked symptoms, and, comparatively speaking, ceases to interfere with life; more frequently, however, it often excites much local irritation, if not suppuration, and usually kills by destroying the kidney by converting it into a suppurating cyst. Small stones are constantly formed in the kidney and passed through the ureter into the bladder. Large stones may so increase as to form a cast of the pelvis of the kidney (Fig. 378), and at times attain enormous dimensions.

The SYMPTOMS of stone in the kidney are a tendency to rigor, lumbar pain, increased by riding or any jolting of the body, the pain passing down the groin into the testicle of the affected side and causing its retraction, irritable bladder, and blood in the urine. Irritability of the bladder may be the only symptom of renal disease. When the stone enters the ureter, the inguinal and testicular pain becomes increased and a colicky pain appears, attended often with sickness, and even collapse, the bladder becoming more irritable and the urine more bloody. When the stone passes, all these symptoms suddenly cease, the bladder irritation probably alone remaining. As time goes on and the local irritation becomes worse some suppuration in the kidney may occur. As long as the ureter remains open and pus makes its escape into the bladder the symptoms are not urgent; but should the ureter become closed by the stone or some inflammatory change, the pus will collect and give rise to lumbar renal abscess. At times this lumbar swelling may be felt; indeed, in thin subjects, with one hand in the lumbar and the other in the hypochondriac region, a calculus may by palpation even be made out in the kidney; this examination will be made occasionally with advantage when the patient is under an anæsthetic. The lumbar swelling may so increase as to form a large cystic abdominal tumor. When the ureter is obstructed, this result will take place more rapidly than when it is open, from the accumulation of pus; but when it is open, the pus flows into the bladder and passes with the urine as turbid urine. When allowed to settle in a porringer or glass, its presence will be readily detected. Pus poured into the bladder from the kidney or elsewhere is mixed with but little mucus, but when formed in the bladder is mixed with much. Pus and mucus secreted from the bladder is constant in the urine; when from the kidney, it may be intermittent. Dr. Owen Rees has pointed out the value of the tincture of galls added guttatim to the urine of patients who may be suspected to be suffering from renal calculus, this tincture producing an immediate flocculent precipitate of a light-brown color when any of the extractive matters of the blood are present (*Brit. Med. Journ.*, October 21, 1876, p. 518). He also asserted that a heavy and continued pain over the sacrum may be the only prominent clinical symptom of this affection.

TREATMENT.—When a stone has formed in the kidney, the happiest result is its passage into the bladder; which end can be facilitated by the administration of diluents, particularly water, as well as alkaline preparations of potash, such as the citrate, tartrate, or bicarbonate. When strong evidence exists of local irritation, opium or henbane, given by either the mouth or the rectum, is a valuable drug; while a subcutaneous injection of morphia over the affected kidney at times acts most beneficially. Fomentations about the loin and groin or the warm bath also give much relief.

When the stone is passing down the ureter, the same practice is to be followed, a warm bath and a full dose of opium often relaxing the parts and favoring the passage of the stone. The administration of an anæsthetic by inhalation may, when the pain is severe, under these circumstances, also be tried. In a case I was called upon to see, where extreme agony existed, instantaneous and permanent relief followed the practice, the stone having passed during the inhalation of the chloroform.

When the stone has become impacted in the kidney and gives rise to periodical attacks of pain and constant uneasiness, each attack being worse than the last, important questions occur to the surgeon: Is it to be allowed to remain, where it may in all probability set up irremediable disease if not destruction of the kidney? or is an attempt to be made to remove it by surgical operation? The answer at the present day is very decided: The surgeon should remove the stone.

RENAL SURGERY.

This branch of surgery has reached a definite position; and if it rises in value as it has risen in interest, a wide surgical field has indeed been opened. It is to Simon of Heidelberg that we are indebted for its birth, in that he in 1869 first designedly removed a kidney with success. He did so for a urinary fistula of the ureter which had resulted from an ovariotomy.

Since then, writes Clement Lucas in an able article (*British Med. Journ.*, September 29, 1883), "*nephrectomy* (removal of the kidney) has been performed upward of a hundred times. *Nephrotomy*, or incision and drainage of the kidney, has become a much more frequent operation, and renal lithotomy, *nephro-lithotomy*, has been successfully extended to cases where no tumor or sinuses exist:" and the credit of this last triumph must be given to my friend Mr. Henry Morris. (See *Trans. Clinical Society*, vol. xiv. p. 30, 1881.)

A fourth operation, named *nephrorraphy*, must also be mentioned—an operation first performed by E. Hahn of Berlin (*Centralblatt für Chirurgie*, July, 1881)—which consists in cutting down upon and exposing a movable or floating kidney and stitching it to the edges of the parietes of the lumbar wound.

Last, but not least, *paracentesis* of the kidney claims a notice.

Upon each and all of these surgical proceedings a few observations will be made.

Paracentesis of the Kidney.

This operation is valuable for diagnostic as well as for curative purposes, and it may be performed, either by way of aspiration or by means of a trocar, in cases in which it is well to be assured of the presence or absence of fluid in any given dull lumbar swelling.

In hydronephrosis, or dropsy of the kidney, brought about by the retention of urine in the pelvis of the kidney from obstruction of the ureter, in those rare examples of isolated serous or blood cysts of the kidney, and hydatid cysts, this operation is particularly valuable.

For the diagnosis of pyonephrosis it is equally of use, and even where the tumor may turn out to be of a solid nature a fine aspirating needle is not likely to be followed by harm.

The best position for tapping the right kidney "is one halfway between the last rib and the crest of the ilium, between two and two and a half inches behind the anterior superior spine of the ilium" (Morris, *Med.-Chir. Trans.*, vol. lix. p. 242), and for the left, according to Mr. J. Thomson of Nottingham, "the interval between the last two ribs near their anterior extremities" (*Path. Soc. Trans.*, vol. xiii.).

Nephrotomy, or an incision into the pelvis or substance of the kidney, is called for in cases of abscess of the organ, whether from stone or from tubercle, or of pyonephrosis from whatever cause, and for hydronephrosis and hydatid when the simple operation of paracentesis has failed to bring about a cure. It essentially consists of exposing, opening, irrigating, and draining the abscess cavity in the same way as any other abscess cavity should be treated.

I have followed this in practice on many occasions, having in a man cut down upon a suppurating kidney and evacuated several ounces of pus with marked benefit, and in another opened and drained a large suppurating renal cyst through the left loin.

On August 31, 1876, I likewise cut down upon the right loin of a lady æt. 27 whom I saw in consultation with Dr. Moore and Mr. Pocock of Brighton, with a swelling which we diagnosed as renal, and evacuated three pints of fetid pus, the lady making a good recovery. In 1877 I cut into the left loin of a woman with a lumbar swelling and let out a quart of pus with marked benefit, my finger readily passing into the dilated pelvis of the kidney, and in 1883 I opened the right kidney of a man which twelve years before had been seriously injured, and evacuated eighty-six ounces of fetid pus, subsequently irrigating with iodine water and syringing the cavity. He was well in three months.

The operation in its several steps should be the same as that described for lumbar colotomy, the kidney being readily reached and dealt with through such an incision as was there indicated.

Nephro-lithotomy, writes Henry Morris, who was the first surgeon who designedly cut down upon a kidney to remove a stone (see *Clin. Soc. Trans.*, vol. xiv. p. 30, 1881), "should unhesitatingly be done in all cases in which symptoms of renal calculus continue uninfluenced by medical treatment and are sufficiently severe to interfere mate-

rially with the comfort and usefulness of the patient's life. If for several months a person has been subject to more or less constant pain in one loin and along the ureter, and perhaps, also, in the testicle of the same side, if there have been recurring attacks of renal colic, and especially if with these symptoms there is occasional hæmaturia or the urine is constantly charged with a little pus or albumen, we have the conditions not only justifying, but demanding, an exploration. If, in addition to these symptoms, a small calculus or a little calculous matter has been passed *per urethram*, there is almost absolute certainty of the presence of a stone; at the same time, it must be recognized that symptoms strongly suggestive of renal calculus arise from other causes than stone."

Operation.—I give this in the words of Mr. Morris: "An incision is made four and a half inches in length parallel with, and three-quarters of an inch below, the last rib. The structures divided are the same as in nephrotomy. If the quadratus lumborum be so wide as to contract the deep part of the wound, its outer edge may be incised to the extent of half or three-quarters of an inch. All bleeding vessels having been twisted and hemorrhage quite stayed, the assistant should stretch the edges of the wound widely apart by suitable retractors, and the operator, with two pairs of dissecting forceps, tears through the perirenal fat. As he approaches the back of the kidney there will be sometimes noticed a difference in the character of this fat, that immediately in contact with the kidney being finer in texture and of a delicate primrose color. If, from the presence of the stone, there has been inflammation in the tissues around the kidney, this appearance will not be expected, and the whole of the tissue will probably be dense and tough.

"When the kidney has been fairly reached, the index finger should be passed carefully over the whole of the posterior surface of the organ, including its pelvis, and any inequality of surface or increased hardness or resistance at any particular spot should be searched for. During this tactile exploration—indeed, throughout the whole of the examination of the kidney—the abdominal walls of the patient should be well supported by an assistant or well-arranged pillows, so that the kidney should not be pushed forward by the exploring finger. If nothing suggestive of the presence of a stone is thus felt, the kidney should be freely exposed to view by drawing aside the edges of the wound, and a fine needle should be passed into the renal substance. This should be done in a systematic way and in several places, if the stone be not at once struck, introducing the needle here and there, so as to puncture in succession the several calyces of the kidney, in one or other of which experience tells us the stone usually rests. If in the course of the digital exploration some one spot gives more resistance than the rest, this should be first punctured, but otherwise the puncturing should be done in a well-planned manner. On this point I would lay great stress, as it is quite possible to puncture in a dozen places and yet to miss the calculus.

"If by this means the calculus is not detected, the search should not be given up until the fingers of the right hand are passed round the outer edge of the kidney, and the front surface felt over in the same way as the posterior. Whilst doing this, in order to give counter-resistance to the exploring finger, the kidney may be pressed against the psoas muscle or be squeezed between the finger and thumb. Despite all these means, a calculus may escape detection. I have recently removed by lumbar nephrectomy a healthy kidney for a calculus the size of a marble imbedded in it, but which I could not localize. The man recovered well, but the loss of a good kidney is a very regrettable feature in the case. The kidney becomes very hard and tough under the prolonged irritation of a stone, so that, whilst the whole organ feels firmer than natural, any slight difference in the degree of resistance of one part is more difficult to appreciate. This hardness of the renal substance should make the surgeon very suspicious of a calculus, and future experience will, I think, encourage him, when this condition is present, not to be satisfied either that no stone exists or that nephrectomy must be performed until he has made such an incision into the kidney as will open each of the calyces. Kidney wounds are known to heal readily, and, whilst the risk of such an incision would not equal that of nephrectomy, the subsequent condition of the kidney would be preferable to the possession of only one of these organs.

"Having detected the stone by one or other of the methods above described, the overlying parts of the kidney should be cut into with a probe-ended straight bistoury, and then with a scooping movement of the finger, introduced through the incision, the stone, unless a branched or very large one, can be raised to the surface of the parietal wound on the point of the finger; or a pair of forceps might be passed into the kidney by the side of the knife and the stone seized and withdrawn. The finger is, however, much to be preferred; and if the incision is small, as it ought to be, the finger serves the purpose

of plugging the renal wound, whilst it lacerates the renal tissue to the necessary extent. By this plan the hemorrhage is minimized, and the rent made with the finger heals as readily as the cut. When equally convenient to reach the stone, it is much best to open the secreting structure, and not the pelvis, of the kidney. The wound in the former heals better than in the latter, and the chance of a urinary fistula is much less. If the calculus be large and branched, it may possibly be requisite to break it up into two or more fragments and remove the fragments separately. I have known this done in a suppurating kidney, but it is not probable that a stone will attain such a size as to require breaking before removal without having in its growth more or less destroyed the kidney structure. A stone one ounce in weight has been removed entire from a kidney not markedly enlarged nor the seat of advanced suppuration (Bennett May, *Clin. Soc. Trans.*, 1883).

After-Treatment.—The after-treatment is very simple: a drainage-tube should be left in the back part of the wound, and the rest should be closed by sutures. For a time, of course, the whole or greater part of the urine secreted by the injured kidney will be discharged through the loin, but after gradually diminishing this may be expected to cease altogether in from three to four weeks.

"These loin wounds usually heal very quickly. In nephrotomy, as in nephro-lithotomy, some simple dressing, such as lint soaked in terebene and oil or spread with boracic ointment, should be applied over the wound, and the drainage tube should pass through this and be covered with a thick pad of absorbent cotton-wool, iodoform, or Lister's gauze, retained in place by a light bandage. The dressings will require frequent changing, as they soon become saturated with the urine. To keep the bedding dry, a large pad of finely-powdered German moss peat should be placed beneath the loin to receive and absorb the urine, which it readily does.

Dangers of Operation.—The dangers of nephro-lithotomy are not great, so far as we can judge from present experience. The operation hitherto has, it appears, been uniformly successful, but the number of cases as yet recorded is but few. 1. *Hemorrhage* from the wounded kidney is not likely to be serious if the plan suggested above be followed. There may, perhaps, be a formidable-looking gush on first dividing the tissue, as in Mr. Beck's case, but compression with the finger or a sponge will soon check it. 2. *Cellulitis* may follow the operation, but with due precaution as to antiseptic cleanliness and drainage this will almost certainly be escaped. It may, however, occur, and I am aware of one case in which extensive suppurative cellulitis followed an exploratory incision in search of a renal calculus; pus burrowed downward to the pelvis and upward until the abscess burst into the lung, and, though the patient ultimately recovered, he nearly lost his life. 3. *Renal abscess* might possibly follow the operation as the result of wounding an organ already long irritated by the presence of a calculus. I do not know of its having occurred, and it is much more probable that any morbid change started by the calculus would be checked and repaired by the removal of the cause—a result which is proverbially known to occur in other tissues of the body. 4. A renal fistula or a mere superficial purulent fistula may follow; but, though the chances are against it, such a result would be a welcome substitute for the ceaseless pain and chronic invalidism of the condition which it replaces.

Nephrectomy.—This operation has been successfully performed at intervals for years—in some cases on account of injury and in others by mistake, renal tumors having been removed as ovarian; but Simon of Heidelberg was the first surgeon who designedly performed it, and with success, by the lumbar operation.

Dr. Brant of Klausenburg on June 7, 1872, removed the left kidney of a man æt. 27, which had escaped from the loin through an opening caused by a stab four days before. He tied its pedicle in two portions with a silken ligature, and recovery took place without a bad symptom (*Wiener Med. Woch.*, November 29, 1873).

On December 2, 1873, Dr. A. Campbell of Dundee removed the kidney that was the subject of cystic disease through an abdominal incision, having mistaken it for an ovarian tumor, and the patient, who was a widow æt. 49, made a good recovery. The pedicle was ligatured with carbolized catgut (*Edin. Med. Journ.*, July, 1874).

Nephrectomy may be performed by an *abdominal* or *lumbar* incision, and there can be no question that the latter is the right one to select in all cases in which the kidney is small and yet sufficiently diseased to justify its removal.

The abdominal incision should be reserved for large tumors which cannot be taken away by the lumbar.

Lumbar nephrectomy is at all times a serious operation, and is only to be undertaken

after mature consideration. "It is only permissible," says Simon, "when a patient's life is seriously threatened by disease and all other remedies have failed." It should, however, be entertained when one organ is seriously disorganized from calculus or other causes, and when the minor operation of nephrotomy has failed or seems inapplicable; when the organ is the seat of a tumor otherwise incurable or the subject of urethral urinary fistula seriously interfering with life's duties. It seems likewise applicable to certain examples of ruptured or wounded kidney in which nature cannot be expected to bring about or has failed to secure repair.

It should never be undertaken unless evidence exists as to the probability of the other kidney being healthy, as evinced by the normal condition of the urine as to quantity and quality, and the absence of albumen over and above what can be explained by the presence of pus due to the disease of the affected organ.

It does not appear to be applicable to disorganization of the kidney from tuberculous disease, such an affection being usually double.

The operation itself should be made much upon the same lines as that of nephrolithotomy.

Should more room be required in the incision, it can be gained by a vertical cut made at right angles to the spinal end of the wound, this incision not only facilitating the removal of the kidney and the application of ligatures to its pedicle, but being very favorable for drainage.

The kidney should be enucleated by the finger, and this is, as a rule, readily effected. Where difficulty is felt the capsule may be left.

The pedicle should be secured by means of a double ligature of silk passed on a long and strong aneurism needle, and it is well to tie the ureter and vessels separately. The kidney should next be well dragged out of the wound, and to facilitate this the lower ribs should be forcibly drawn upward. If the ligatures do not appear to be securely tied, a second one should be put on; before the kidney is separated the pedicle should be cut through with scissors.

All bleeding points should at once be seized as they present themselves and secured either by ligature or forceps. All the ligatures should be cut short. Any wound of the peritoneum should be sutured. The wound should then be treated as any other deep wound—that is, well washed out with iodine water and drained. Enough sutures should be introduced into the wound to keep the parts together, but a free outlet should be left. A large pad of absorbent cotton and gauze may then be adjusted over the loin, to absorb discharge, and the patient left alone for nature's reparative powers to bring about a cure. The simplest food is the best; the nearer a milk diet can be maintained, the better. Convalescence has been generally secured in about four weeks.

Abdominal nephrectomy is to be entertained only when the lumbar is inapplicable; and had I to do it, I should use the incision which approaches that illustrated in Fig. 169, the upper end of the incision being made to pass more obliquely below the last rib. Langenbuch of Berlin makes his along the outer border of the rectus abdominis, the midpoint of the incision corresponding to the umbilicus.

All the details of the operation are to be conducted with all the care observed in an ovariotomy.

The statistics of the operation up to the present are:

Out of 96 cases well reported, 54 recovered and 42 died. Of these, 46 were made by the abdominal incision, of which half died; whereas of the 50 made by the lumbar, 31 recovered and 19 died. The result of the operation seems, however, to turn more upon the disease demanding it. Thus, of 18 cases for cancer, 9 died; of 16 cases for floating kidney, 6 died; of 7 for urethral fistula, all lumbar, 6 recovered, 1 died.

Nephrorraphy is an operation undertaken for the relief and fixation of a kidney which is freely *movable* behind the peritoneum. It is clearly inapplicable to such rare cases as are found to possess a mesonephron and are *floating* kidneys. It should, however, be undertaken only in exceptional cases. It consists in a lumbar incision as for nephrotomy, after the exposure of the kidney, which is greatly aided by an assistant pressing it well to the wound from the abdomen; the capsule and cortex should be firmly stitched by six or more sutures to the margins of the lumbar wound, the wound subsequently being left to granulate. The operation was first performed by Hahn of Berlin in 1881, and it has been repeated by Langenbuch, Martin, Küster, Esmarch, Weir, Newman, and others with sufficient success to justify its adoption in such exceptionally troublesome and painful cases of the affection as are occasionally met with.

The OPERATION, up to the exposure of the kidney, is the same as that of nephrotomy,

and later on consists in the application of strong catgut sutures between the renal capsule and the margins of the lumbar wound. The kidney by this process is stitched back to the loin, where it becomes ultimately fixed. The wound after this should be dressed so as to heal by granulation. The operation of nephrectomy for this affection is hardly justifiable.

For papers on this subject refer to THOMAS SMITH'S, *Med.-Chir. Trans.* for 1869; to LUCAS'S, *British Med. Journal*, September 29, 1883; to HENRY MORRIS'S, *Ashhurst's International Encyclopæd. of Surgery*, vol. v.; CZERNY of Heidelberg, *Trans. Internat. Med. Congress*, 1881, vol. ii., p. 249; BARKER, *Trans. of Med.-Chir. Soc.*, vols. lxiii. and lxiv.; HAHN, *Centralblatt für Chirurgie*, July 23, 1881; *American Journal of Med. Science*, January, 1873, July, 1874, also paper by HARRIS, 1882; DAVID NEWMAN, M. B., *Glasgow Med. Journal*, August, 1883; DR. WEIR, *New York Med. Gazette*, 1884.

CHAPTER XXI.

DISEASES OF THE BLADDER AND PROSTATE.

IRRITABLE BLADDER.

ALMOST every disease of the urinary organs from the kidney downward manifests its presence by some bladder symptom, and that symptom is usually what is called an *irritable bladder*—that is, the patient passes urine more frequently than natural, with or without pain.

Such a symptom may indicate some slight deviation from the healthy relations that ought normally to exist between the bladder and its contents, or the presence of a severe if not fatal organic disease. It may be a result of some irritation of the glans penis associated with retained subpreputial secretion or an adhesion between the glans and prepuce, or it may be due to a serious cerebral or spinal affection. It may indicate kidney, bladder, prostatic, or urethral disease, and, in many instances it is the one symptom that has induced the patient to seek advice. The *irritable bladder*, therefore, though only a symptom, is clinically an important one, and demands elucidation at the commencement of a chapter on bladder affections.

Irritability of Bladder in Children.—When this symptom is well marked in a male child, the condition of the penis should first receive attention, since, if the prepuce be long or adherent to the glans penis, and the secretion from Tyson's glands, from want of cleanliness, have accumulated and become indurated, there will be strong reason to believe that the irritability of bladder is the direct product of these apparently simple causes; for any of these conditions of the penis are sufficient to produce every degree of bladder irritation, and a cure can be obtained only by their removal. To secure this end all retained secretion should be taken away, adhesions between the glans penis and prepuce carefully separated, and, if the prepuce be long, circumcision performed. If, however, on a careful examination, no such conditions are to be observed, the state of the bladder should be inquired into, and for this purpose a sound passed (an instrument with a bulbous extremity being preferred) (Fig. 385); and if a stone be detected, the cause of the symptom will be clearly explained, as well as the practice to be followed. It must be remarked, also, that if a calculus be the cause, a careful inquiry will probably detect the presence of other symptoms, such as pain after micturition, hæmaturia, and an occasional interruption to the flow of urine, the intermitting urinal flow being very characteristic of the presence of a stone, although all these symptoms may be present in irritable bladder from an adherent prepuce. When the stone cannot be felt, it is not at once to be assumed that no such cause exists; for on a subsequent examination it may readily be discovered, the calculus having been probably covered by one of the folds of mucous membrane of a partially-contracted bladder. If, however, a second examination fail to strike it, the condition of the bladder should receive attention; and if to the sound its mucous lining feels rough and the presence of the instrument cause more or less pain and a desire to micturate, the urine will probably be found altered in character, and after standing will show a cloudy deposit of mucus, if not of pus, the latter deposit being very rare, however, in young subjects.

TREATMENT.—Under these circumstances the general health of the child will require attention, as it may happen that some slight aperient or alterative or an alkaline mixture

of potash, or perhaps a tonic, may be required, the object being to make the urine as unirritating as possible, and thereby to allow the vesical mucous membrane to return to its normal condition. Rest, also, as far as it is possible to be secured, should be enforced. The diet ought to be of the simplest nature and meat given in moderation, since it will probably be found that the urine is unnaturally loaded with lithates, if not with lithic acid; and this tendency to the deposition of such ingredients would be increased by the free administration of animal food. When, however, a case of irritable bladder in a child presents itself in which none of the conditions alluded to are found, and in which the penis, urethra, and bladder appear perfectly natural, the state of the rectum should be inquired into, the presence of worms, and more particularly of ascarides, being quite sufficient to produce an irritable condition of the urinary organs. These may be removed by a jalap purge or an enema of some bitter vegetable infusion such as quassia, but the condition of the digestive apparatus will require attention, as influencing the presence of worms.

Excluding the presence of a stone as a cause of irritable bladder in young children, and in obstinate cases the probability of some villous growth, this affection is not one of serious importance if its true cause can be accurately recognized, since the conditions upon which it depends are easily remediable, and the irritability of the bladder rapidly disappears on their removal.

Irritability of Bladder in the Adult.—In adult life this symptom cannot be regarded in such a favorable light as in a child, since it is too often associated with conditions which are of a very serious nature and are by no means readily removed, although in the adult, as in the child, a congenital or an acquired phimosis, with a contracted preputial orifice or adhesions between the prepuce and the glans penis, is a sufficient condition to produce this symptom.

As a symptom of stricture the irritable bladder is not without its value, and, as a rule, it indicates considerable narrowing, as well as probably a contraction, which has been so gradual in its progress as to escape notice until this irritability of bladder enforced more accurate observation and induced the patient to seek advice. It must be regarded as a result, therefore, of a urethral stricture which can be relieved only by the removal of its cause. Doubtless it is produced by some chronic inflammatory action of the vesical mucous membrane, and as such requires treatment—viz., the dilatation of the stricture, absolute rest, and the administration of alteratives.

As a symptom of *enlarged prostate* (or of atony of the bladder in the aged in whom no prostatic enlargement exists) this irritability of bladder is a complication of serious import, for in both classes of cases it is due to a want of power on the part of the bladder to empty its contents—in the one case from a mechanical obstruction caused by the prostatic tumor, in the other from a loss of power in the parts, the residual urine under both, partially decomposing, becomes ammoniacal, and in this way acting as an irritant to the mucous membrane of the bladder, thereby giving rise to the irritability.

The treatment of these cases is not, therefore, a task of difficulty, the removal of the residual urine and the prevention of its subsequent retention by the cautious employment of a catheter being the most important, together with the frequent washing out of the bladder with warm water or water medicated by some solution of morphia, opium, quinine, boracic, or nitric acid.

The recognition of the cause of the symptom, however, is the main point to be remembered, the practice to be followed readily suggesting itself when the cause is understood. As a sign of gravel an irritable bladder is of importance, and a careful examination of the urine will determine its true meaning. As a symptom of calculus in the bladder it is constant and valuable, although in some cases of stone it is extraordinary how little irritation the presence of a calculus will produce. As a sign, also, of organic disease of the bladder, irritability must not be passed over. The obscurity of this class of cases is, however, very great, and the correctness of diagnosis must rest upon the combination of many symptoms, none being of greater value than another. In women this symptom is a common accompaniment of uterine affections, while in both sexes it is often associated with rectal disease.

Last, but not least, this irritability may be the product of a *renal affection*, the urethra and bladder being perfectly sound. When, therefore, bladder symptoms exist and a careful examination fails to discover any disease in the bladder or urethra, it may fairly be assumed that some renal affection is the cause. But a careful chemical and microscopical examination of the urine is alone sufficient to enable the surgeon to arrive at anything like a correct diagnosis.

Irritability of bladder may also be produced by some cerebral or spinal disease, but the fact can merely be alluded to in these pages.

The passage of a large quantity of urine, as in diabetes, should not be mistaken for irritability of bladder.

Inflammation of the Bladder.

Cystitis is a common consequence of stone, prostatic disease, stricture, or gonorrhœa, and is usually *chronic* or *subacute*, the more acute symptoms mostly supervening upon the chronic. As an *acute* idiopathic disease it has been described by authors, but clinically such cases are very rare. The most acute are those occurring in gouty subjects as a catarrhal affection.

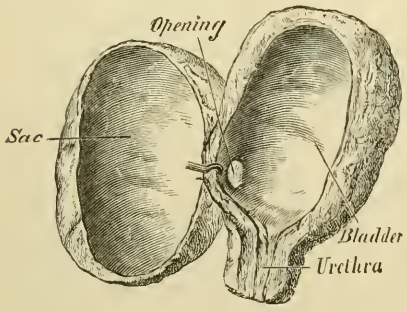
The *chronic* form is the direct consequence of local irritation produced by the presence of a tumor, stone, or other foreign body, although it is found wherever the flow of urine is interfered with from either prostatic disease or urethral obstruction, the bladder in these cases being irritated by the retained and decomposed urine as well as by its own ineffectual attempts to evacuate its contents. A similar result likewise ensues when the bladder is paralyzed and unable to expel its contents from overdistension, spinal injury, or disease. It is under these circumstances the more acute forms of cystitis and the worst pathological conditions are found.

Subacute cystitis is commonly the result of gonorrhœa, the inflammation of the urethra spreading to the bladder.

The seat of the inflammation is the mucous membrane, which becomes rough, covered with flakes of adherent lymph and phosphatic secretion, thickened, and at times ulcerated, and in the acute forms of the affection detached in fragments or as a whole and thrown off as a slough. This latter condition is generally met with in the bladder of the paralytic and in women who have had their bladders much distended from retention. It is probably as much due to the deficiency of nerve supply as to the intensity of the inflammatory mischief, rough catheterism having often too much to do with it.

In chronic cases the walls of the bladder become greatly hypertrophied from overaction, thick muscular bands being visible, and where the obstruction to the exit of the urine has been of long standing this thickening of the walls of the bladder is associated with its dilatation. Under these circumstances it is common to meet with sacular dilatations of the mucous membrane, the mucous lining of the bladder becoming pressed outward as a hernia between the bands of muscular tissue forming the walls of the organ. These pouches are usually small, though in exceptional cases (as seen in Fig. 358) they may be double the size of the bladder itself. Into one of these pouches a stone may occasionally fall and rest, thereby becoming encysted. At times these sacculi are multiple.

Fig. 358.



Sacculated Bladder.
(Prep. 208^{75}, Guy's Hosp. Mus.)

Sacculi of the bladder are met with chiefly in male subjects; they were found in 20 out of 3000 post-mortem examinations made at Guy's; in 11 cases of stricture, 5 of stone, 1 of spinal disease, 1 of enlarged prostate. In 1 the cause was not clear. My friend Dr. Hale White recorded these facts with a case met with in a woman at the Path. Society, March, 1883.

Symptoms.—When the disease is subacute, the symptoms are irritability of bladder and inability to retain urine, the desire to pass water being often associated with its uncontrollable passage. The act of micturition is attended with pain and followed by straining, blood being frequently squeezed out by the forcible contraction of the organ. Pain is mostly present above the pubes, in the perinæum and penis, often over the sacrum and in the groin. With these local symptoms there may be those of more or less severe febrile disturbance.

The urine will be found to vary in character according to the cause of the disease. When it has originated from the extension of a gonorrhœal inflammation of the urethra, it will be cloudy from the presence of mucus, or even of pus, and at times stained with blood, this blood having been passed during the act of straining at the end of micturition.

In other cases of chronic disease (*catarrhal cystitis*) the urine will be mixed with grayish, viscid, ropy mucus or muco-purulent fluid, which so sticks to the bottom of the chamber-vessel and together as to fall like a glutinous mass when turned out. The urine will probably, in chronic cases, be alkaline or ammoniacal; in subacute, acid: in neglected cases the discharge of mucus becomes enormous, and phosphate of lime often becomes mixed with the mucus and forms stone.

When ulceration of the bladder is present, all the symptoms are aggravated and the local pain is severe. Bleeding is a common accompaniment, the blood being mixed with the contents of the bladder and passed either as dark-colored urine or as clots of blood.

In the cystitis of gonorrhœa it is probable that the mucous membrane about the neck of the bladder is alone affected; in the more chronic cases of disease the whole surface and submucous tissue are involved.

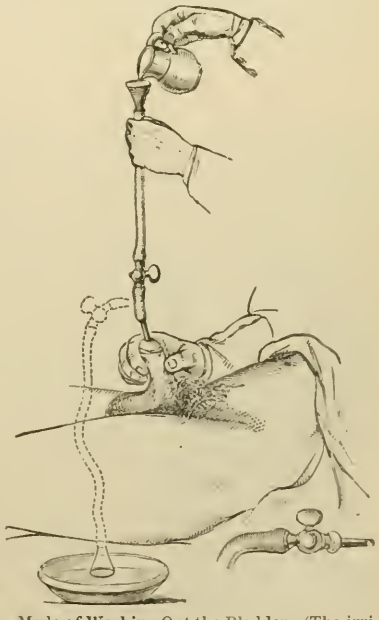
Treatment.—Whatever may be the local cause of the cystitis, the local symptoms require attention, although in order to obtain a cure the removal of the cause is most essential.

Rest in the horizontal posture, hot fomentations or the hot bath, simple diluents such as barley water, linseed tea, milk and water, with alkalies, as the salicylate of soda, citrate, or bicarbonate of potash, in ten-grain doses, three times a day, and, above all, sedatives, are most essential. Of the sedatives hyoscyamus is the best, in half-drachm or drachm doses of the tincture every two or three hours; and where this is not enough opium may be substituted, but where the kidneys are diseased opium should always be given with great caution. The morphia suppository is an excellent remedy; so is an enema of starch with opium. The bowels should be relieved by enemata in preference to purgatives, although, when severe constipation is present, a good mercurial purge is often of value; leeches to the perinæum are sometimes serviceable.

When retention of urine complicates the case, catheterism is called for: and an elastic catheter should be used, with the utmost gentleness.

In chronic cases the infusions of buchu, uva ursi, pareira, or senega, and benzoic acid in ten-grain doses are excellent remedies; the tincture of cubebs or copaiba at times acts also beneficially; the triticum repens, in the form of a decoction, two ounces to the pint, is also a valuable drug. When gout is the assignable cause, colchicum, with five-grain doses of the carbonate of lithia, sometimes acts as a charm, and in some cases of gonorrhœal cystitis the same good effect is often experienced. When stone is the cause, it should be removed; when stricture coexists, it must be dilated; when enlarged prostate or atony of the bladder in the aged is the cause of the cystitis, it is essential to keep the bladder empty by the introduction of a catheter once or twice daily; in severe cases the bladder should be washed out by either a stream of tepid water or medicated solution. Boracic acid, ten grains to the ounce of water, is the best form. Mr. T. W. Nunn speaks highly of a solution of two grains of quinine in two and a half ounces of water with a drop of diluted sulphuric acid. When the urine is fetid, Condy's fluid or a few drops of tincture of iodine, carbolic acid, or of one part of thymol dissolved in seven of glycerine may be added to the water.

Fig. 359.



Mode of Washing Out the Bladder. (The irrigator can may be substituted for the jug and hand.)

In washing the bladder the greatest gentleness should be observed; to force fluid into the bladder by a syringe is dangerous, unless in skilled hands, while to introduce more than three or four ounces of fluid is unnecessary. The best method is by means of the irrigating can or a piece of india-rubber tubing, two or three feet long, fitted to the top of the catheter after its introduction, and the gradual pouring of the water or solution made warm through a glass funnel fitted to the other end. The tubing can be raised to increase the pressure of the fluid, or depressed, according to the necessities of the case, the bladder resenting the slightest distension by its contraction and by the expulsion or elevation of the fluid into the funnel. By these means no harm can possibly accrue to

an inflamed bladder, and the most atonic bladder can be emptied as with a syphon (Fig. 359).

After the fluid has been introduced and left for two or three minutes it should be withdrawn, and fresh fluid poured in where necessary, the funnel being depressed below the level of the bed for emptying the bladder. Anodyne solutions are said not to be of much use in these cases, but I have been in the habit of introducing half a grain, more or less, of morphia, with apparent advantage, after the washing out of the bladder. When the washing out of the bladder increases the irritation, it should be discontinued. At times a double catheter is of use, the injection flowing down one side and the contents of the bladder out of the other.

In the inflamed bladder associated with atony the tincture of the perchloride of iron is a valuable drug, or the dilute nitro-muriatic acid given in twenty-minim or half-drachm doses three times a day; but, in a general way, alkalies are called for, the urine naturally secreted being acid, and so as it is poured into the inflamed bladder becomes an irritant. The diet under all circumstances should be nutritious, but unstimulating, alcohol being given carefully, according to the patient's powers. In all cases, however, of inflamed bladder the surgeon ought to remember its cause, which is generally due to some obstruction to the flow of urine or local cause of irritation, and for a cure the removal of its cause is essential.

Ulceration of the Bladder.

This is rarely the result of ordinary cystitis, though it may occur in the paralyzed organ, and is met with after death where catheterism has been frequently employed and in cases of stone. It is likewise found in tuberculous subjects, from the breaking down of tuberculous material, as well as in cancer. The disease is indicated by the same symptoms as exist in inflamed bladder, with more local distress, more blood in the urine, and greater pain after micturition. There is usually also much constitutional depression and want of power. I have seen two cases in which extravasation of urine above the pubes resulted from this disease, one of which recovered and the other died.

Treatment.—The indications for treatment are similar to those for cystitis, opium being freely used as a suppository or an enema. All mechanical interference should be avoided unless absolutely called for, and then it should be of the gentlest kind. It is a question, however, whether in the severer forms median perineal cystotomy would not be a sound practice; the urine would then flow away as secreted and a chance given to the bladder to recover itself; at any rate, the operation would give relief. I have done this on several occasions with success.

Tubercular Disease of the Bladder.

This is a rare although a real affection, and is confined to young middle age. It is generally associated with the same disease of the kidneys, prostate, vesiculæ seminales, and testicles, and shows itself as a deposit of tuberculous matter in the mucous and submucous tissue, which when it breaks down forms an ulcer. It is usually accompanied with symptoms of irritable bladder and painful micturition, the latter symptom being more common when ulceration has taken place.

Rest in the horizontal posture is essential in this as in all bladder affections, anodynes, tonics, and nutritious food being of great value. My friend the late Mr. Poland told me that in a case of tubercular disease of the bladder attended with ulceration (which was under Mr. Aston Key's care when he was a dresser, about 1840), where the suffering was severe, Mr. Key suggested the propriety of laying the bladder open as in lithotomy, and thus allowing the urine to flow off as soon as it reached the bladder. The patient, however, was too far exhausted from advanced lung disease to allow of its performance. Mr. Key stated that in another case, where the disease had not made so much progress, he should not hesitate in performing the operation. The bladder in this one was found almost stripped of its mucous membrane, and what remained was studded with tubercular deposits. Mr. Key called it phthisis of the bladder. At the present day Mr. Aston Key's suggestion of cystotomy would probably be performed.

Tumors of the Bladder.

A bladder, anatomically being constructed of mucous membrane, fibrous and muscular tissue, may be the seat of papillomata, the innocent *villous growth*; myxomata, or

mucous polypus; FIBROMATA, or fibrous growth; MYOMATA, or muscular. Containing, likewise, as it does, epithelial and connective-tissue elements, it may be the subject of EPITHELIAL CANCER, as well as of a SARCOMATOUS GROWTH; and to this list DERMOID tumors may be added. Any one of these growths may be intramural or polypoid. The papillomata are found in children as well as in adults. The other forms of tumor belong more to the middle-aged or old. Growths are as common in the female as in the male sex.

FIG. 360.

Villous Growth in Bladder, with Hypertrophied Walls of the Organ. (From drawing 36⁸³, Guy's Hosp. Mus.)

The **papillomatous** are mostly pedunculated, villous, and single. Many are sessile and multiple. When single, they are generally attached to the base of the bladder—that is, to the trigone and orifices of the ureters, when at times their long villous ends or prolongations of natural villi are carried by the urine stream into the urethra, where they may be broken off and expelled or cause obstruction.

In exceptional cases the mucous surface of the bladder may be more or less covered with these villous or sessile papillomatous growths; indeed, instances are on record where the ureters or calyces of kidneys were involved.

These growths are benign and of slow growth; they may last for six or more years.

Fig. 360 well illustrates the ordinary appearance of this variety of tumor, with the changes brought about in the bladder from its presence.

The **myxomata, fibromata,** or **myomata** are mostly single tumors and develop as polypoid or irregular-shaped outgrowths, the expulsive action of the bladder doubtless doing much toward making the growths polypoid. They affect both sexes equally, and are more frequent during young than old life; they may grow from any part of the bladder, but generally from the trigone.

In Fig. 361 the disease was extensive. It was described by Sir A. Cooper as "tumor of the mucous membrane of the bladder everted, polypoid excrescences producing symptoms of stone." Fibrous and myomatous tumors are, however, rare. In 1883 I had a man æt. 60 under care with a fibrous growth springing from the fundus; it had caused symptoms for four years.

CANCERS.

These are generally of the epithelial form, but examples of the hard and soft varieties have been recorded. They are generally sessile and infiltrating the walls of the bladder, but they may assume the villous shape. The affections may be primary; more commonly, in women, the bladder becomes involved by the extension of disease from the uterus, and in men from the rectum. Under all circumstances the disease is one of middle or advanced age.

FIG. 361.

Polypoid Outgrowths from Mucous Membrane of Bladder. (Preparation 2104²³, Guy's Museum.)

In the notes of a case before me, however, the disease appeared in a man æt. 28; in ten others the ages varied from 48 to 69.

SYMPTOMS.—All bladder tumors give rise to much the same series of symptoms, which may be brought under three headings—namely, *irritability of bladder*, passing on to incontinence, *hæmaturia*, and *pain*.

The irritability may be very slow in its increase, intermittent in its action, or rapidly progressive. In the majority of tumors it is the earliest sign; in the villous or papillomatous it rarely appears till other evidence of bladder trouble, such as hæmaturia, shows itself. When it has appeared, it usually steadily increases in severity, till at last the bladder refuses to retain urine and incontinence ensues.

The progress of villous disease is usually slow, but it may be rapid. Thus, in one case of villous growth, the notes of which are before me, in a man æt. 37, the irritability of bladder and hæmaturia had been gradually increasing in severity for *eight years*, and after death the mucous lining of the bladder was found covered with

a growth, and the walls of the bladder were so thickened that when removed, empty of urine, it was as large as a cocoanut; whilst in a second case, which occurred in a man æt. 70, there had been symptoms for only *two months*, and the first was hæmaturia. No pain or difficulty in micturition had appeared till five days before his admission into Guy's. He died from suppurating kidneys. In this case the disease was localized to the trigone of the bladder.

It is to be remarked also that in villous disease there may be intervals of days, and sometimes weeks, between the attacks of hæmaturia, the urine between-whiles being normal. In cancerous disease these intervals are rare.

It need hardly be said that the urine should be most carefully examined in all these cases and its sediment and clots washed, for in one case a small fragment of villous growth may often be found in it, and in another *masses* of epithelial or spindle-shaped cells—not isolated cells, however numerous—when the diagnosis will be complete.

With the same view, when a catheter has been passed, the contents of the instrument should be well washed and examined. I have on several occasions found pieces of growth in the instrument, and in the case of a female child who had several attacks of hæmaturia I caught in the eye of my catheter a small villous growth, pulled it away, and cured the child.

Ultzmann (*Villous-Ueber Hematurie*, 1878) has described a condition of urine met with in villous growths which he considers diagnostic. It consists of a coagulating of the urine, which seems free from blood, into a glutinous mass soon after it has been passed, the mass consisting, apparently, of fibrine. A. Stein of New York, in his able memoir on bladder tumors (1881), confirms the observation. It would seem as if in some cases liquor sanguinis exudes from the villi, and in others blood.

Hæmaturia, or the passage of blood-stained urine, or blood in abundance or in clots, is a constant symptom, and in the villous growth it is usually the earliest. In such it is also very intermittent—that is, it may appear to-day and not reappear for three or four months. The same may be said of other growths, but, as a rule, when hæmaturia has appeared with them, it is persistent. It is, however, usually a later symptom.

The blood generally shows itself toward the end of micturition, the stream of urine being at first clear, and then toward the end red. In exceptional cases, however, the blood may pass first.

The position of the growth must have much to do with this symptom, growths about the trigone being more liable to bleed when the bladder contracts than the same situated nearer the fundus.

In exceptional cases of tumor of the bladder there is no hæmaturia.

Pain is not a constant symptom of this disease, although uneasiness from frequent micturition may be troublesome; pain becomes more marked as the irritability of bladder increases and inflammation shows itself, and in the later stages of trouble it may become intense.

The pain is usually felt in the penis after micturition, but a dull suprapubic pain is by no means an uncommon symptom of bladder growth.

Pain over the sacrum and in the perinæum and rectum, and pains shooting down the thigh, are not rare. Lumbar pains are of frequent occurrence toward the close of the case.

Diagnosis.—From what has been said as to symptoms it will be gathered that it is in exceptional cases alone a true diagnosis if any special vesical growth can be made out, although when hæmaturia, steadily-increasing irritability of bladder, and pain are present, and these symptoms are unrelieved by treatment, the diagnosis of a local vesical cause may fairly be made. A bimanual, vaginal, and suprapubic combined examination will often prove of great value in aiding diagnosis in women and in men. The same method applied through the rectum may be equally serviceable.

But for a completely satisfactory digital exploration of the bladder a full dilatation of the female urethra is absolutely essential, and a central perineal urethral incision in the male, by which the membranous portion of the urethra is opened to allow of direct digital exploration, is equally called for.

Sounds and catheters are of use, but they are of uncertain value, and more particularly when compared with "direct digital bimanual exploration," as strongly advocated by Sir H. Thompson.

Treatment.—Little more than palliative treatment has hitherto been generally employed in these cases, as bladder tumors have been little understood. Yet an old surgeon of Guy's (Warner) in 1747 incised the urethra of a woman æt. 23 who was suf-

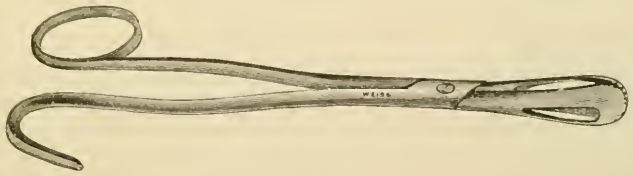
fering from a polypus and put a ligature round the peduncle of a growth the size of a turkey's egg with complete success; Dessault, after removing a stone from a male, successfully twisted off a polypus that he found in the bladder; and Mr. Birkett (*Med.-Chir. Trans.*, 1858), in a striking example of the disease occurring in a female child æt. 5, applied a ligature to the growth, but the patient died with suppurating kidney the effect of the disease; and in many cases the practicability of successful operative interference is not discouraging.

I also in 1864 removed a villous growth from a woman's bladder with the écraseur with complete success. Other cases may also be found in surgical literature in which operative interference has been employed, and more particularly in women. In male subjects the instances are very few. Civiale in 1827 used to crush vesical growths with the lithotrite with some success, and Covillard, according to Crosse (*Urinary Formations*, 1835), was the first to perform designedly perineal cystotomy for a tumor with success. Crosse repeated the operation in 1834, Billroth, Volkman, and Kocher in 1874, Humphrey in 1877, and Davies-Colley in 1880. At the present time Thompson has ably advocated it. Suprapubic cystotomy has been employed in still fewer cases. In considering these operations it is always to be remembered that a case of bladder tumor when left to nature can have but one ending, and that is death. Every recovery, therefore, aptly writes Thompson, "is a clear gain." In all cases of persistent bladder irritation and hæmaturia in which the cause is doubtful a full exploration of the bladder in the ways previously suggested, by urethral dilatation in the female and a perineal incision into the membranous portion of the urethra in the male, should be undertaken.

Should no tumor be found, the injurious effects of the operation may be put down as very slight; should one be found to exist, its removal will probably be effected. Thompson writes that out of 27 explorations he found and removed growths in 12 cases, and that 5 of them were effectually cured.

The growth, when discovered, should be removed by scoop écraseurs or forceps of different shapes and sizes. Thompson uses cutting as well as crushing forceps. The latter are probably the safer and most efficient (*vide* Fig. 362).

Fig. 362.



Thompson's Bladder Forceps.

When the whole growth can be removed, so much the better; but should this not be possible, the surgeon may console himself with Thompson's opinion that "a complete ablation of the growth is not absolutely essential to success; that as cicatrization takes place this process by degrees leads to solidification of the tissues at the point at which evulsion was made." In female subjects the operation is far easier than it is in the male. In both, however, it should be considered and adopted in any case of suspected tumor. When any difficulty is experienced in finding or removing the growth, it may be well to leave the case alone for twenty-four hours, as, from a case related to me by my friend Mr. H. Morris, it seems that when a bladder containing a growth is drained the growth itself may be partially extruded through the wound by the natural expulsive action of the bladder, when it can be readily seized and treated.

Under certain circumstances a suprapubic operation might be preferable to the perineal; for example, when the growth is at the fundus or very large. In a case of my own of fibrous growth in the fundus I regretted that I had not chosen it.

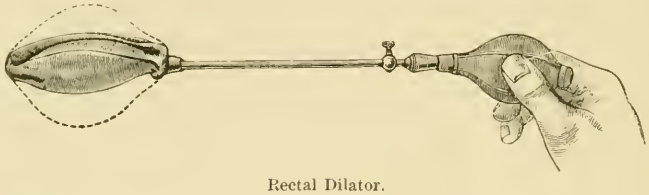
The surgeon, when considering any operation upon the bladder, should remember that its position is capable of undergoing great changes; that in the adult, when flaccid, it lies behind and below the level of the symphysis; and that when moderately distended it may be uncovered with peritoneum for about one inch at its upper and anterior surface. He should likewise be aware of what Dr. J. G. Garson of the College of Surgeons has demonstrated (*Edin. Med. Journ.*, October, 1878) when the rectum is distended with a rubber oval bag measuring when full ten inches in circumference (the size of a man's hand)—that the bladder is raised out of the pelvis into the position it occupies in the new-born child, and that under such circumstances the bladder is uncovered above the symphysis

for about three inches. It would seem by Garson's experiments that the bladder is raised out of the pelvis by stretching the prostatic portion of the urethra to nearly double its ordinary length, and that with the elevation of the bladder its posterior peritoneal covering is considerably raised, Douglas's pouch, which is normally about two and a half to three inches from the anus, being raised to three, four, and even more, inches. My own observations with the rectal dilator upon the cadaver support Dr. Garson's views.

The bearing of these facts upon suprapubic bladder operations is palpable.

For distending the rectum an oval india-rubber bag ten inches in circumference, with a metal perforated tube for introducing and filling purposes, may be employed (Fig. 363).

Fig. 363.



Rectal Dilator.

Dermoid tumors of the bladder are of rare occurrence; and when they occur, they are probably ovarian in their origin, and are discharged through the bladder. In exceptional cases they may have a bladder origin—that is, may have been developed within the walls of the bladder and at a later stage broken down, ulcerated into it, and been then discharged.

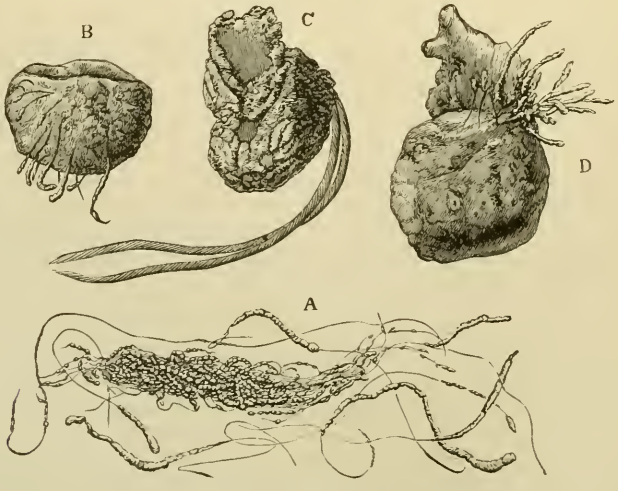
In the following case this explanation seems to be the only reasonable one.

A married lady æt. 30, the mother of two children, came into my hands on June 30, 1883, to be operated upon for some hemorrhoidal trouble; she then complained of slight bladder irritability of a few days' standing. Previous to this she could hold her water for hours; indeed, on hunting-days she could do so for eight or ten. I regarded the bladder symptom as one associated with her rectal trouble.

After the operation the symptoms continued, and on July 10, without any apparent cause, intense fever and constitutional disturbance appeared, and on the 11th her bladder symptoms became intensified.

On the 12th some urethral obstruction occurred, and on examination with a view to relieve it I removed a bundle, the size of a penholder, of fine hairs covered with phosphates from the urethra (Fig. 364, A), which bundle is now in the museum of the Royal

Fig. 364.



Dermoid Growth removed from the Bladder with hairs (A) covered with phosphatic concretion. B, First part removed C, Pedicle with ligature. D, Growth and pedicle finally removed.

College of Surgeons. With the removal of this all constitutional symptoms disappeared. The bladder irritability, however, lasted, and for the next six weeks small phosphatic cal-

culi, formed on long and short hairs, were being frequently passed. Some of these hairs were a foot long; the majority were, however, short.

On several occasions I washed the bladder out with relief. Early in September the patient was fairly comfortable; she could hold her urine for hours and pass it without pain. She then left London. Suddenly, however, toward the end of the month, all her severe symptoms returned, and with aggravation. The urine became charged with mucus, and likewise with blood.

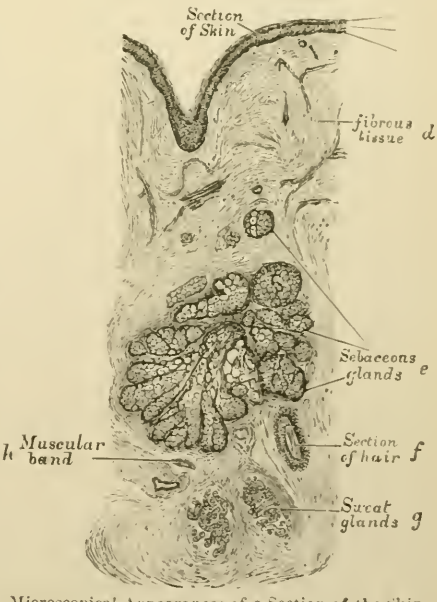
Early in October I saw her again, when she was passing masses of phosphatic concretion formed on hairs, with urine full of mucus and pus. A bladder exploration was then arranged.

On October 29 this was performed, Sir H. Thompson kindly assisting me with Mr. H. Morris.

For a full examination an anæsthetic was given, and the urethra rapidly dilated with the small instrument I am in the habit of using (Fig. 438). I then introduced my finger into the bladder, and at once came down upon a mass of phospatic concretion matted on hair. This I removed, and, having done so, discovered hanging from the upper wall or fundus of the bladder a polypoid outgrowth about one inch and a half long, the pedicle of which apparently came out of a kind of annular depression in the walls of the bladder. These facts were likewise recognized by Sir H. Thompson. I then seized the growth with a pair of Thompson's fenestrated forceps (Fig. 362) and drew it well down, and having done so, applied to its pedicle a ligature of chromicized catgut.

Sir H. Thompson then, whilst I held the growth forward, cut off its summit, which measured three-quarters of an inch across (Fig. 364, B). This turned out to be what it appeared at the time—a piece of coarse but perfect skin with sweat and sebaceous glands and hair follicles. A few hairs were on the surface, but the bulk of them had been removed (Fig. 365).

Fig. 365.



Microscopical Appearances of a Section of the Skin covering the Dermoid Tumor.

After the operation all the bladder symptoms were relieved for a few days; they then increased, but were again relieved when the pedicle with its ligature came away on the tenth day (Fig. 364, C). After this everything went on well for a few days till the catamenia appeared, when bladder troubles returned and rapidly increased; indeed, they soon became as bad as ever.

On November 17 another exploration was made of the bladder, when it was found that the pedicle of the growth which had been left had much increased, and had apparently protruded as far again as ever from the annular ring in the bladder which was noticed at the first operation.

The polypus was consequently again seized and drawn down, and as Sir H. Thompson was about to apply a ligature to its pedicle the whole thing came away with the forceps in my hands. The growth removed was as large as that which existed at the first operation, and it came away, pedicle and all (Fig. 364, D).

After the operation the annular ring noticed was very distinct, and into this the finger was passed with ease. I need, however, hardly add that neither I nor Sir H. Thompson was too curious as to where it led.

With this operation all trouble ceased. The bladder in two days was well able to retain its contents. In three days all blood and mucus disappeared from the urine. In a week the urine was normal. At the end of two weeks from the operation, with the exception of a little soreness, no bladder symptoms existed, and within one month the patient was as well as she had ever been in her life. She is now as if she had never had a bladder trouble.

Remarks.—I believe this tumor to have originated from a dermoid cyst which had been implanted in the walls of the bladder during the patient's fœtal life; that it began to undergo changes in its interior a few days before she came into my hands for rectal

mischief; that the tumor, then acutely inflamed, gave rise to the severe constitutional symptoms mentioned and opened into the vesical cavity; that at its opening it discharged, firstly, the mass of fine long and short hairs covered with a very thin layer of phosphatic deposit, and, secondly, the innumerable larger masses, or rather calculi, which were subsequently passed or removed; that for a time, the cyst having partially discharged itself, the bladder trouble subsided, and when it reappeared it was from the formation of almost a calculus upon the remaining hairs which the dermoid cyst then contained; that this cyst then began to turn inside out, and from the expulsive action of the bladder to become polypoid; that at the first operation, when the bulk of the projecting growth was removed, this process was not completed, such having taken place only at the second.

In support of these views Dr. Goodhart's following report of the preparation will be read with interest:

"The specimens submitted to me were a rounded, knob-like piece with a truncated end, which had been removed at the first operation, and an elongated, somewhat irregular-shaped mass, presumably the stalk from which the first piece had been removed. Both had long dark hairs growing from them in considerable numbers, and these were mostly thickly covered with a shell of yellowish phosphatic matter.

"A section of the knob showed it to consist, apparently, of a layer of thickish skin, with a quantity of tough fibrous tissue beneath it (Fig. 365). The opinion furnished by the naked eye was quite borne out by microscopical examination. No lengthy description need be given of it, as a very truthful drawing of a part of the section has been made by Miss Boole, which will show at once that the growth is composed of perfect skin. At *a b c* is the epidermal layer, with its horny layer at *a*, the intermediate layer at *b*, and the mucous layer at *c*; below this comes a thick layer of fibrous tissue, *d*, which has been reduced in the drawing to allow of the introduction of the deeper part. At *e* is a sebaceous gland; at *f* a section of a hair cut obliquely and surrounded by its cuticular sheath; while at *g* are seen sections of sweat glands.

"The only question that arises from the appearances is as to the existence or not of striped muscular fibres.

"In many parts of the section are broad bands (a piece of one is shown at *h*) which look very much like muscular fibre, but the striation is nowhere distinct enough to pronounce with any certainty. I am inclined to regard them as an embryonic form of muscle midway between the striped and unstriped varieties. But, however this may be, the nature of the growth is clearly similar to what upon the surface of the body would be called molluscum fibrosum—that is to say, a polypoid overgrowth of the corium and subcutaneous tissue, covered by the epidermal layers.

"In the urinary bladder, naturally, the first—and, indeed, the one—question is how such an excrescence could get there, and I believe that only one answer to that question has any degree of probability attached to it.

"It has been suggested that it is some congenital growth, like a hairy mole upon the skin; but taking into account the history, which conclusively establishes that the patient was perfectly free from any vesical trouble of any kind until recent date, and knowing that hair in the bladder always provokes a deposition of phosphates and causes extreme worry and cystitis, it is inconceivable that this growth has been in the bladder any length of time. It must, therefore, have come from the outside. The history, again, points strongly toward this conclusion, for the first symptoms were those of high fever and subsequent cystitis. I take it, therefore, as probable that at that time some inflammation occurred around this growth, situated outside the bladder, that ulceration occurred in the bladder and the polypus escaped into the cavity, and that when once there it immediately provoked, as such a growth might be expected to do, the intense cystitis that then happened.

"When we further have to decide whence the growth sprang, the facts of the case are, I think, quite unmistakable; for before the growth had been detected a mass of hair had been discharged from the bladder, with a quantity of phosphatic matter (? fatty matter). This surely indicates that a dermoid cyst had opened into the bladder, and the growth in question was no doubt a sprout from its wall. Whether the dermoid cyst sprang from the ovary, as is naturally *most* probable, or came, as is not unknown, from some other part of the pelvis, there is no evidence in the preparation to determine."—James F. Goodhart.

Atony of the bladder is a want of muscular power in the bladder to expel its contents, as a result of overdistension from either compulsory retention or organic obstruction, or from some cerebral disturbance or from fever, etc. It has been often falsely

described as paralysis of the bladder; but whereas, in paralysis, the loss of power is due to a want of nerve supply, in atony it is the result of want of muscular power due to exhaustion or overstretching. It may be associated with retention or with incontinence, the latter condition showing itself when the bladder is overcharged, the dribbling of urine being a mere overflow.

TREATMENT.—As the cause of atony of the bladder is muscular exhaustion, so the treatment consists in giving the organ muscular repose, which can be done by catheterism. Where the atony is not very complete, the drawing off of the urine twice a day may suffice to allow the organ to recover its tone and to act naturally; but when the atony is extreme, it may be necessary to introduce a catheter into the bladder and to fasten it there, the urine being allowed to run away as secreted through a tube fixed on the end of the catheter. By this means the most complete rest can be given to the organ. Where the bladder is sluggish in resuming its functions, tonics such as iron may be given, with the local injection into the bladder of some stimulant, as cold water, diluted nitric acid, or tincture of iron in the proportion of four to ten drops to the ounce; but catheterism alone, as a rule, is enough, these cases generally recovering unless the cause has been acting for too long a period. When recovery is slow, an electric shock through the pelvis is often beneficial.

Paralysis of the bladder is a far more serious affection than atony, since the want of power is due to deficiency in nerve supply; which deficiency may be partial or complete. It is met with whenever the spinal cord is injured or diseased, as in brain shocks or disease, in reflected irritation from disease about the rectum, uterus, etc., and after any operation upon these parts. It may be caused also by a severe mental shock or the general depression from a fever.

TREATMENT.—The cause of the paralysis in these cases must always have an important influence on the practice of the surgeon, but the necessity of keeping the bladder empty is essential under all circumstances; for this purpose a soft, full-sized elastic catheter had better be passed two or three times a day, the greatest gentleness being observed in the manipulation. When anything like cystitis is present, it should be locally treated by washing out the bladder, etc., as already indicated. To leave a catheter in the bladder is not desirable. When professional aid is not always at hand, a nurse may at times be entrusted with a full-sized vulcanized india-rubber catheter without a stylet and allowed to pass it; it has simply to be pushed down the penis, and can do no harm. In fever cases the plan is a good one.

Hysterical retention is not rarely met with in women, and is difficult to treat. Catheterism is to be resorted to only when necessity compels, hysterical patients usually micturating when the pain of retention calls loudly for relief. The cold douche over the lower part of the abdomen is a good local remedy for the affection, and not too pleasant for the patient to wish for its repetition. Moral treatment is always called for in these cases, and is more needful than surgical interference.

VESICO-INTESTINAL FISTULA.

This is sometimes met with, and it is probable, in the majority of cases, that the ulcerating process commences in the bowel and involves the bladder in a secondary way.

SYMPTOMS.—It usually first manifests its presence by the passage of wind with the water, some little irritability of bladder having previously existed; feces, liquid or solid, soon follow, giving rise to fetid urine and severe bladder symptoms, the pain of foreign material in the bladder being very marked when the large intestine or rectum is involved; the liquid motion of the small intestine does not appear to give rise to the same local distress as the solid.

DIAGNOSIS.—There is no difficulty in recognizing this mixture of urine and intestinal contents. When flatus passes *per urethram*, the condition may be suspected; when the urine has a fecal odor and color, the condition gives rise to something more than a suspicion; and when solid feces are visible, the diagnosis is certain. In doubtful cases the microscopical examination of the sediment of the urine will readily reveal its nature. At times the feces may obstruct the urethra and cause retention.

In looking into the history of these cases there will usually be found some bowel symptoms, some diarrhœa or dysenteric affection, some symptoms of stricture or cancer of the bowel; and, although this affection may be found associated with cancerous disease, it seems more frequently to be the result of the simple perforating ulcer of the bowel.

Treatment.—When a fecal fistula has once formed between the bowel and bladder, the hopes of an unaided natural cure are very feeble; when solid motions are mixed with the urine, but little can be done except by an operation to palliate the suffering that is produced. For a time the bladder may be emptied of its contents and by being washed out freed of its local irritant, but the truce can be only for a limited period, another action of the bowel being to a certainty followed by a fresh entry of feculent material into the bladder, with all its evil effects.

When liquid motions or small intestine contents communicate with the bladder, the symptoms are not nearly so distressing, and the necessity for interference is thereby diminished.

The only means the surgeon has at his disposal by which relief can be afforded is colotomy; and when the rectum is the seat of the disease, whether cancerous or otherwise, lumbar colotomy ought to be performed. By it the feces are diverted from their unnatural channel and discharged through the loin, and all the miseries of bladder complication are effectually relieved. When the ulceration is of a simple kind, there is some prospect of its closing; when of a cancerous nature, such a result cannot be expected; but under both circumstances a large amount of relief is immediately afforded and life prolonged.

I have had four cases of vesico-intestinal fistula, in which this operation, lumbar colotomy, has been performed with marked success; one lived six years after the operation, and died, æt. 70, from ruptured heart; the second is still alive and well, eleven years after the operation; the third died four months after the operation, from kidney disease. Mr. Holmes, Mr. C. Heath, and Mr. Pennell of Rio have had similar cases. (For further information *vide* Holmes's paper, *Med.-Chir. Trans.*, 1866–67, and case, with remarks, by author, *Brit. and Foreign Quarterly*, January, 1869; and *Clin. Soc. Trans.*, 1872.)

Incontinence of Urine

is met with under two very different conditions—in the one during sleep, when the will of the patient is in abeyance, the neck of the bladder ceasing to act, from want of power, and giving rise to *nocturnal incontinence;* in the other the incontinence is only *a result of overdistension* and is a mere overflow. The first form is common in children, the second in adults. Incontinence, however, in both the child and the adult, may be due to bladder irritation from the presence of a stone or other foreign body, and it will then exist during the day rather than at night. It may also follow the operation of lithotomy from injury to the sphincter of the neck of the bladder.

Incontinence in the child is a very troublesome, and often a very obstinate, affection. It is, notwithstanding, generally curable, and even in very bad cases, as puberty approaches, the symptom disappears, though in exceptional instances the infirmity continues in after-life. The child is generally brought to the surgeon because he "wets his bed," when too often the history reveals the painful fact that punishment has been severely tried before professional advice was sought; and it is needless to add that by such a process no cure can be effected. In many instances the habit is in a measure induced by a want of attention in the parents to take up the child during the long hours of the night.

Treatment.—When the prepuce is very long or adherent, circumcision should be performed.

When the urine is chemically wrong in any of its constituents, remedies must be given to correct the faults, and a limpid watery urine in a child, as in an adult, is always an irritant.

With respect to medicines, the tincture of iron is doubtless the best, and next to it belladonna in the form of either the tincture or the extract, but in some instances the combination of the two is excellent.

I have tried and been disappointed with full doses of chloral given at bedtime. It acts at times wonderfully well, but at others appears useless. When employed, it should be given on an empty stomach. Tonics are the right medicines, one form often succeeding where another fails, iron, quinine, nux vomica, and zinc being, as a rule, better than belladonna. The tonics by day and a night-dose of belladonna have sometimes proved of value.

The bowels should always be attended to and the presence of worms considered, and it is well to have the bowels relieved at night before going to bed. When the child is not too young, cold baths, with or without salt, should be used; and every means should

be employed to maintain the general health, although it must be added that children who labor under this infirmity are rarely feeble and cachectic. The child should be encouraged to sleep on his side in preference to his back, and for this end a handkerchief with a knot in it may be fastened round the pelvis, the knot being adjusted over the sacrum.

Dr. W. Steavenson records (*Brit. Med. Journ.*, January 6, 1883) cases of frequent micturition treated by electricity with the most beneficial results. In these, one electrode, in the form of a spinal disc, was connected with the positive pole of the battery and applied to the lumbar region, and the other electrode was applied above the pubes or to the perinæum; through these a weak current was passed for a few minutes daily. Relief of the symptoms from the commencement of the treatment and by complete cure, usually within a fortnight, have been the results.

In cases of extreme obstinacy some surgeons apply a solution of nitrate of silver ten grains to the ounce to the neck of the bladder, and, it is said, with advantage. Others apply mechanical means to prevent the flow of urine, such as an india-rubber ring around the penis, or cover up the urethral or preputial orifice by a layer of collodion. Good reports have been given of these practices. I cannot say that I think well of any such means and have never adopted them, as they seem wrong in principle.

Nocturnal incontinence in a child generally means atony of the sphincter, while incontinence during the *day* suggests bladder irritation, generally a stone or urethral obstruction.

Incontinence in the adult, as already stated, means, as a rule, overfulness of the bladder, the real condition being one of retention from some obstructive urethral or prostatic disease, bladder atony, or paralysis. It may, however, be due to stone or to a preceding lithotomy. In women it may be associated with some uterine displacement or disturbance, some urethral disease or injury. In men and women severe spine disease may cause it.

Treatment.—To treat it the cause must be ascertained, and the introduction of a catheter is probably a sound practice to follow as the first means of investigation, since it settles at once the question of retention and often detects the true cause, thereby giving a clue to the treatment to be adopted—viz., the removal of the cause.

True incontinence, however, is met with in severe cases of general or local paralysis, in functional derangement of the cord from venereal excesses, and still more frequently from self-abuse, such patients often complaining of "inability to stop the flow of urine when commenced." It is, however, seen in old people with prostatic enlargement, the third lobe being enlarged and projecting forward between the lateral lobes, so as to open out the neck of the bladder and render it constantly patent, the incontinence being due to overflow the result of retention.

In these cases the use of a urinal is the only remedial means at the surgeon's command, except in those caused by venereal excesses, when tonics, cold bathing, and absolute abstinence from all injurious habits may effect a cure.

DISEASES OF THE PROSTATE.

The diseases of the prostate gland are of importance. Placed, as the gland is, at the neck of the bladder and at the commencement of the urethra, on the one hand it may suffer as a consequence of urethral disease, and on the other, when diseased, it may give rise to bladder symptoms of considerable severity. Thus, as a consequence of urethral disease, gonorrhœa, or stricture, it may inflame or suppurate and, mechanically interfering with the flow of urine, cause retention. It may, indeed, undergo nearly complete destruction from suppuration, the direct consequence of stricture, and possibly of extravasation. When enlarged from hypertrophy, stone, cancer, or any other cause, it may mechanically interfere with the flow of urine, and so give rise to bladder symptoms or bladder disease of no slight severity, and later on cause incontinence from overflow by the special direction of the growth.

Inflammation of the Prostate.

This is usually due to the extension backward of a gonorrhœal inflammation or to the presence of a stricture. It may arise, too, as a complication of cystitis from the irritation of a calculus, the passage of a sound, or the application of caustics. It is also not unknown as an idiopathic affection in gouty subjects and in those who indulge in sexual excesses.

Symptoms.—It is generally ushered in with pain in the perinæum and bladder irrita-

tion, the act of micturition being attended and followed by pain, and often tenesmus. Defecation ceases to be a painless act, and is attended with uneasiness, sometimes with difficulty, and at last with distress. On manipulating the perinæum a deep-seated fulness will be felt, and on passing the finger into the rectum the prostate will be found enlarged, spongy, and painful: rigors probably will form one of the general symptoms, with febrile disturbance, which will vary in severity according to the acuteness of the affection.

If the inflammation advances to abscess, a throbbing pain at the neck of the bladder will be felt, with a constant desire to go to stool, and retention of urine is almost sure to occur.

If left alone, the abscess will probably burst into the urethra and discharge itself externally, with immediate and marked relief; while in other cases it may open into the rectum. It sometimes happens that the abscess is ruptured during the passage of a catheter to relieve retention or during a rectal examination.

When the disease is *acute*, the local as well as the general symptoms will be severe; but when *chronic*, they will be less marked, though not less characteristic.

As a result of acute inflammation *chronic disease* is often left, as indicated by pain in passing water, irritability of bladder, a thin urethral discharge, cloudy purulent urine, and perineal, pelvic, and anal pain, which is increased on exercise or excitement. There may be at times some little loss of power in emptying the bladder, pain in sexual intercourse, or frequent nocturnal emissions.

Treatment.—When the symptoms are acute, few remedies give more relief than the application of fifteen or twenty leeches to the perinæum, followed by a hot hip bath and the subsequent application of a linseed poultice made with the decoction of poppies or mixed with the extract of opium. A good purge should also be resorted to, and alkalies given, with sedatives such as morphia or opium, allay pain.

When retention of urine complicates the case, a catheter must be passed, a catheter coudé being the best; but the warm bath and opium should first have been employed, as the introduction of a catheter under such circumstances is always painful and may do harm. When required, an elastic instrument which has been well softened and oiled should be selected. Rest in the horizontal posture should be observed and liquid diet given.

When an *abscess* has formed and there is evidence of deep-seated perineal suppuration, an incision in the median line of the perinæum should be made; and, indeed, if suppuration has not taken place, the operation, by lessening tension, will be followed by relief to the symptoms.

When the abscess has opened naturally, no surgical interference is usually required, although in exceptional cases, where one abscess is followed by another and the deep parts about the gland, instead of undergoing repair, are becoming more involved, a perineal incision should be made. When the suppuration is the result of a stricture and has probably been caused by extravasation, the propriety of dividing the stricture and laying open the perinæum down to the prostate cannot be questioned.

In chronic inflammation, whether the sequel of the acute or not, when attended with suppuration, the practice already advised should be followed. When no suppuration exists, but only enlargement, counter-irritation by means of small perineal blisters is of great use, and the elevation of the pelvis with a pillow at night is also valuable. Tonics, as a rule, are required, with the iodide of potassium. The bowels should never be allowed to be confined, the best laxatives being some saline medicine or one of the natural mineral waters, such as Vichy or Pullna. All mechanical interference with the prostate should be avoided and the nocturnal emissions treated on general principles, and not as being due to a local cause, tonics, generous living, and fresh air doing more toward hastening recovery than anything else. Over-exercise must be avoided and sexual excitement forbidden.

Abscesses occasionally occur around the prostate and give rise to very many of the same symptoms as a prostatic abscess. They are more apt, however, to make their way toward the posterior part of the perinæum into the ischio-rectal fossa. As soon as they are recognized they should be opened by one or two deep incisions in front of the anus on either side of the median line. On one occasion I let out by two incisions about a pint of pus that had accumulated in this part, and produced complete retention of urine for several days. Immediate relief and a good recovery followed the operation.

Hypertrophy of the Prostate.

This is a general term applied to a chronic enlargement of the gland which is not inflammatory, but is generally believed to be a common consequence of old age; indeed, it has been regarded as a part of a general senile change. Pathological investigations, however, have taught us that, although this is an affection of advanced life, it is in no way a necessary attendant on old age, the vast majority of old men having nothing of the kind.

When present, it is usually met with in subjects over sixty. Thompson has not met with an example under the age of fifty-four, and after many dissections of the prostates of elderly men he found an appreciable enlargement of the organ in one-third of the cases, but only in one-third of these was it enough to cause symptoms during life.

Pathology.—The disease is generally believed to be a hypertrophy or overgrowth of natural tissues, and in a certain proportion of instances this is doubtless the case; but in others the enlargement is clearly caused by the development of distinct glandular tumors embedded within the structure of the gland, which may be squeezed out of the organ upon division of the tissues covering them in. They are sometimes merely covered by the capsule of the prostate, while at others they are well placed within its structure; at times they are single, at others multiple, and rarely give rise to any other than mechanical symptoms. When these growths are situated in what is called the third lobe of the prostate, they give rise to symptoms of obstruction and bladder irritation precisely similar to those caused by the genuine enlargement or hypertrophy of the gland itself. These fibrous or glandular tumors are analogous to those found in the uterus. This hypertrophy is now known to be, as shown by Ellis and others, a mere increase in the natural fibrous, muscular, and glandular structure of the organ. The enlargement is mostly general, and as long as the vesical or third lobe is not materially enlarged or the urethra encroached upon it is extraordinary to what a size the prostate may attain without giving rise to any special symptoms. It is, indeed, only when the so-called third lobe increases bladder-ways and interferes mechanically by its size or the direction of its growth with the act of micturition that any marked symptoms are produced. In the preparation from which Fig. 366 was taken this condition is well shown.

Fig. 366.

Enlargement of the Third Lobe of the Prostate, with Dilatation and Hypertrophy of the Bladder.

The effect of an enlargement of the prostate upon the urethra is very variable. At one time the prostatic urethra will be elongated to twice or more its normal length, while at another it will be tortuous, this condition being caused by an unequal enlargement of the lateral lobes. In a third class the urethra will be more or less obstructed. In the bladder other changes are found, and the sudden projection upward of the vesical or third lobe is the most common; yet when with this there is an enlargement of one or other of the lateral lobes, a great irregularity of the urethra is the result.

This enlargement of the prostate may so derange the course of the muscular fibres about the trigone of the bladder as to produce a bar or ridge that mechanically interferes with micturition. Guthrie and Mercier have described such a bar as occurring independently of these changes, the bar consisting of the elastic structure and mucous membrane of the neck of the bladder. Thompson also asserts that in "very exceptional instances the bar is undoubtedly to be met with." I have never known such a bar as that last described, and give it only on the authority of the names quoted. It is said to occur earlier in life than prostatic enlargements and to give rise to similar symptoms. Hypertrophied prostates are sometimes met with measuring four inches in diameter, and are common at half that size. They have been found to weigh ten or twelve ounces, the normal weight of the prostate being four and a half drachms.

Symptoms.—So long as the vesical orifice of the urethra is not mechanically encroached upon prostatic enlargement may proceed to an extreme degree without giving rise to any definite symptoms, and retention of urine is very often the first feature that attracts notice. But under these circumstances it generally will be found that the patient has had for some time a difficulty in micturition, that the bladder has hesitated to contract when the desire to pass urine manifested itself, and that either there has been less force in the expulsion of the fluid than formerly or the water has flowed in a more languid stream.

Irritability of the bladder will generally be present, the act of passing urine being

rapidly followed by the desire to do so again, and the difficulty of the act gradually increasing.

As the disease progresses a feeling of weight and fulness in the perinæum and of irritation about the rectum will soon appear, the rectal irritation and the irritability of bladder increasing equally, till at last the two acts of defecation and micturition take place together, the violent straining and tenesmus giving rise to prolapse of the rectum or piles and leading the patient to believe that the bowel complication is the cause of his disease, if not the disease itself.

At a still later period, and as the result of the bladder being unable to empty itself, a residuum of urine remains behind, and the bladder consequently gradually expands from its accumulation and becomes exhausted by its ineffectual expulsive efforts. The urine, moreover, at the same time decomposes and acts as a direct irritant to the mucous membrane of the bladder. In this way inflammation of the bladder, and subsequently incontinence from the overflow of a distended organ, is produced, this inconvenience existing day and night.

The ultimate result of this affection left to nature is the same as that of all obstructive urethral diseases: from the pressure of retention the bladder suffers first, and subsequently the ureters and kidneys; organic renal disease is thus set up and the powers of life are gradually sapped by exhaustion, death being often hastened by severe bladder symptoms, hæmaturia, or uræmic poisoning.

A physical examination of a patient laboring under this disease will probably reveal a bladder more or less distended, and the passage of a catheter, even after the patient has, to the best of his belief, emptied his bladder, will prove the presence of several ounces of urine which may be ammoniacal, this change in the urine being produced by its partial decomposition from its retention and admixture with the mucus of the bladder. In neglected cases the urine will be fetid and may contain blood. The passage of the catheter will also reveal the nature of the obstruction at the neck of the bladder.

On passing a finger into the rectum the enlarged prostate will be felt, and in some cases may nearly fill the pelvis. When pus or fluid exists, fluctuation will be detected and when inflammation, pain. To make this examination nicely the finger should be well anointed, and at the moment of its introduction the patient should be told to bear down. It should be remembered, however, that to appreciate any abnormal condition of the gland it is necessary to be familiar with its normal state.

As a consequence of this affection and of the change produced in the urine, a phosphatic calculus may form; but its presence is often masked by the symptoms of the disease. When, however, there is increased pain after micturition, pus and blood in the urine, and extreme pain in the penis, a calculus may be suspected; and when fragments of phosphatic deposit pass, the suspicion is confirmed. In all long-standing cases of prostatic disease with bladder symptoms the presence of a stone should be suspected, although when present it is often difficult of detection, from being protected by the enlarged prostate, behind which it usually lies.

A patient with enlarged prostate is liable to retention from any sudden chill, overdistension of the bladder, mental emotion, or fatigue; indeed, such accidents usually reveal the presence of the affection.

Treatment.—Medicine has no influence in checking the progress of this disease or in causing absorption of the enlarged organ, but surgery can do much in the way of palliating the symptoms that are the direct result of the enlargement and neutralizing its evil effects.

The most essential point is to secure the complete evacuation of the bladder's contents, and also to see that no residuum of urine remains in the bladder to irritate the organ and decompose, thereby setting up cystitis. This should be done by the passage of a catheter. In early cases where but little bladder irritation exists the passage of the instrument once a day may suffice: but when the residual urine is in any quantity and the bladder has lost some of its power of contraction, the introduction of an instrument two or three times in the twenty-four hours may be necessary, and in worse cases, where the bladder has lost all power of contraction on account of its overdistension from chronic retention, it may be necessary or expedient to tie a catheter in the bladder and leave it there for a time. The surgeon must remember, too, that instrumental aid, though valuable, is a necessary evil, and should not be resorted to more frequently than the necessities of the case demand.

Where instruments are required, a flexible full-sized catheter is the best. When silver instruments are employed, one with a large curve should be selected, the back of

the catheter riding more readily over the enlarged vesical or third lobe of the prostate than a shorter one. To assist in the introduction of any instrument into the bladder, the passage of the index finger of the surgeon's left hand fully into the rectum is an excellent aid, and under all circumstances the pelvis of the patient should be well raised on a pillow.

When an elastic instrument is used and some difficulty experienced in riding over the obstruction, success may often be achieved, as soon as the end of the instrument has reached the vesical end of the urethra, by the withdrawal of the stylet with one hand and the pressure of the catheter into the bladder with the other. Force should never be employed, gentle manipulation and care almost always sufficing to secure success.

When the disease is chronic and the necessity of catheterism is probably permanent, the patient should be taught to pass a gum elastic catheter for himself, a few lessons and a little confidence being all required for the purpose.

When the bladder, from overdistension, has lost all power and it is necessary that it should have complete rest to allow it time to recover its tone, a catheter may be fastened in; and if the instrument sets up much bladder irritation, a good compromise may be found in the practice of leaving it in at night and removing it during the day. When the introduction of the instrument is attended with great difficulty, it may be expedient to leave an instrument in for some days; but under these circumstances the bladder should be washed out through the catheter daily.

The vulcanized india-rubber catheter is a good form to employ for this purpose, although at times it causes more urethral irritation than the gum elastic. A winged or other self-retaining catheter may be employed when difficulties are experienced with keeping in the simpler form.

When retention is present and catheterism impossible, the surgeon may be called upon to puncture the bladder *per rectum* or to aspirate it above the pubes in order to give relief. When severe cystitis exists and the agony of catheterism becomes unendurable, a clean perineal incision into the membranous portion of the urethra and the introduction into the neck of the bladder of a soft catheter, to enable the urine to flow away as secreted, is a desirable measure.

General Treatment.—With the local treatment of this affection the general must not be neglected, although in importance it is quite secondary. When cystitis exists, it must be treated upon the principles previously laid down. The general condition of the patient must be maintained by means of good diet and sufficient stimulants. The skin should be kept warm and all sudden chills avoided; the bowels kept open, but not loose; pain should be relieved by sedatives and sleep secured by hypnotics; tonics are often called for, the preparations of iron being, as a rule, the best.

Exercise should be taken when there is no inflammation of the bladder or other reason to forbid it, walking and driving being the best forms: and under these circumstances the local distress from the affection may be rendered very light and life prolonged for many years with comfort.

Patients with this affection should once a day, as a matter of habit, pass urine on their hands and knees, the bladder in this way having more power to evacuate its contents; and the mucus and other more solid contents, which otherwise would lie behind the prostate, are got rid of with greater certainty.

Atrophy of the prostate is often found in the aged and in the young, and in rare cases it is due to some arrest in its development. In the majority it is genuine atrophy or fibroid degeneration, probably caused in some by syphilis. Such a condition, however, does not give rise to any symptoms by which it can be recognized during life, nor is it a cause of any distress.

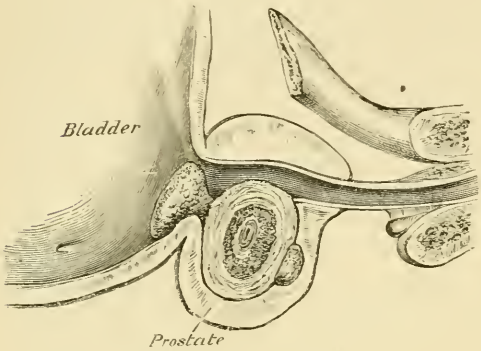
Calculi of the prostate are not rare, and may be found embedded in the organ as small stones varying in size from a grain of sand to bodies of much larger dimensions. They are often very numerous, are sometimes amorphous, but are generally laminated. Wollaston says they are composed of eighty-four per cent. of phosphate of lime, one-half per cent. of carbonate of lime, and fifteen per cent. of animal matter.

"The prostrate gland, like other glands, is liable to an inspissation of its secretion, producing small yellow, sometimes red, pale or colorless bodies scattered throughout the follicular structure. These at first are said to consist entirely of organic matter, which Virchow believes to be derived from a peculiar insoluble protein substance mixed with the semen, but sooner or later these formations are believed to irritate the mucous membrane, causing phosphatic depositions which become encrusted upon the organic matter, and thus the genuine prostatic calculi are formed" (*Poland*).

Symptoms.—When embedded in the organ and not interfering in any way with the urethra, they cause no symptoms; when encroaching upon the urinary passage, they may cause obstruction, but certainly must give rise to urethral, and probably to bladder, irritation. They are accompanied occasionally by ulceration and suppuration of the surrounding parts.

A prostatic calculus may project into the urethra and increase the urethral portion, subsequently extending backward into the bladder and forming a prostato-vesical calculus. In *Guy's Hospital Reports* for 1857 a case reported by Poland, with references to others, will be found (Fig. 367). The calculus has a dumb-bell shape. In all these cases the urethra is usually pervious, the passage of a sound, however, as a rule, detecting its presence, a grating sensation being experienced in the passage of the metal instrument over the stone, but no ring will be heard. A large prostatic calculus may also be felt *per rectum*.

Fig. 367.



Prostato-Vesical Calculus.

Treatment.—When a prostatic calculus gives rise to sufficient symptoms to indicate its presence and by its size is likely to prove troublesome, it should be removed by a perineal section, by such an operation as median lithotomy, the incision stopping short of the bladder when the stone does not involve it. In this way Dr. Barker (*vide* Druit's *Vade Mecum*) removed a large stone nearly five inches in diameter with success. When the stone or stones give rise to few symptoms of importance, they should be left alone; occasionally they pass naturally *per urethram*. The greatest argument against operation, unless absolutely essential, is found in the fact that these calculi are mostly multiple and often exist in both lobes of the prostate.

Cancer of the prostate occurs but seldom, and is generally of the soft kind: indeed, as Dr. Walshe stated in 1846, "the evidence of the occurrence of true scirrhus of the prostate is defective."

Symptoms.—The symptoms are those of enlargement, and increase rapidly in severity, the disease being attended with more frequent and profuse hemorrhage than the ordinary hypertrophy. The blood follows the straining which attends the act of micturition, and appears as pure blood; after catheterism it is often profuse. The disease may be primary, but is commonly secondary. It cannot exist for any time without giving rise to glandular enlargements in the groin or along the iliac vessels, when, as a rule, the patient's powers rapidly yield.

Treatment.—The treatment is only palliative, the surgeon dealing with symptoms. All instrumental interference should be of the gentlest kind and as little as possible. Pain must be relieved by opium and the general powers maintained by good nourishment and stimulants.

Tubercle of the prostate probably, as a rule, only occurs as a part of a general tuberculosis, and until the deposit is breaking up or by its presence is producing some suppurative action it gives rise to no symptoms by which it can be recognized. It is too often associated with renal or bladder disease, and the local prostatic mischief is lost in the more general affection. It is quite possible that some of the cases of so-called idiopathic abscess of the prostate are the result of the breaking down of this deposit, but there are no clinical data to enable the surgeon to diagnose the presence of this disease, and there are, consequently, none other than general rules of treatment to be mentioned.

CHAPTER XXII.

STONE IN THE BLADDER, AND ITS TREATMENT.

Before passing to the subject of stone in the bladder it appears desirable to consider, though briefly, that of urinary deposits, organic and inorganic, as the value of a sound knowledge of what the urine may contain, either in *suspension*, in *solution*, or in *precipitation*, is to the surgeon as indispensable for successful practice as to the physician.

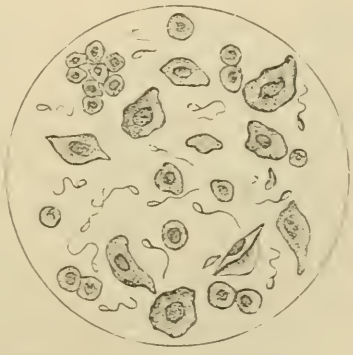
The student should remember that healthy urine is a clear acid, amber-color fluid with a specific gravity of 1020 to 1030; that in one thousand parts 954.81 consist of water, 45.19 of solid matters. These solid matters are made up as follows: Urea, 21.57; uric acid, 0.36; extractives, such as creatine, creatinine, xanthine, hippuric acid, ammonia, sarcine, pigment, unoxidized stuphur, phosphorus, mucus, etc., 6.53; chlorine, 4.57; sulphuric acid, 1.31; phosphoric acid, 2.09; potash, 1.40; soda, 7.19; lime, 0.11; magnesia, 0.12. He should further remember that after drinking or after a meal the urine is altered by the nature of the diet and probably diluted, and that the best sample of urine to examine is that passed in the morning before breakfast—the "urina sanguinis" of Prout; when this urine contains any ingredient in excess or in deposit, some important derangement of the system exists. When any of the constituents of the urine are in excess, the balance which normally exists between them and that keeps them in solution is disturbed, and, as a consequence, some deposit takes place. When this excess consists of the *saline* matters of the urine, such as those of potash or soda, urinary deposits and stone are less liable to form, on account of their solubility, than when the excess is found in the alkaline earths; for the salts of lime and magnesia are most insoluble, and consequently, when in excess, soon show themselves as gravel or calculi. For the same reason, uric acid, being very sparingly soluble, is a very common urinary deposit and is a constituent of most stones. When blood or pus is found in the urine, the surgeon has to discover its source. Is the origin of the blood urethral, prostatic, vesical, or renal? Has the pus been secreted by the bladder or been poured into it from the kidneys or other part of the urinary tract? Is the salt the result of some excessive supply of its chemical constituents, some deficiency in the working power of the machinery of the body, or some accidental circumstance? Are the kidneys themselves at fault? or is it that they are called upon to excrete morbid products which have accumulated in the blood from organic or functional disturbance of other portions of the body upon which the existence of healthy blood depends? All these points have to be determined in dealing with any case of urinary deposit, and in the special works devoted to the subject can be found all that is necessary to guide the student.

What I seek to impress here is that urinary deposits are not themselves diseases or to

Fig. 368.

Epithelium from Urinary Passages.

Fig. 369.



Spermatozoa and Vaginal Epithelium.

be dealt with as such. They are always to be accepted as indications of disease, functional or organic, in some of the working organs or other parts of the machinery of the body.

The reader is referred for all special information on these points to the works of Bird, Beale, Owen, Rees, Pavy, Bence Jones, William Roberts, Thudichum, Vogel, and Hassall.

Healthy urine ought to be quite clear. It may, however, be slightly hazy, from mucus or from the deposition of urates in cold weather, without being abnormal. When any deposit has been merely suspended in the urine, it will commence subsiding as soon as the urine has passed. These deposits are mostly organic and derived from the kidneys themselves or the urinary passages. They may consist of **epithelium** cells, columnar or tessellated, from those parts, with more or less mucus. (*Vide* Fig. 368.)

Blood corpuscles or **clots,** crystals of hæmatin, or **pus cells,** may be found.

Renal Casts.—Waxy, granular, oily, bloody, or purulent (Fig. 370).

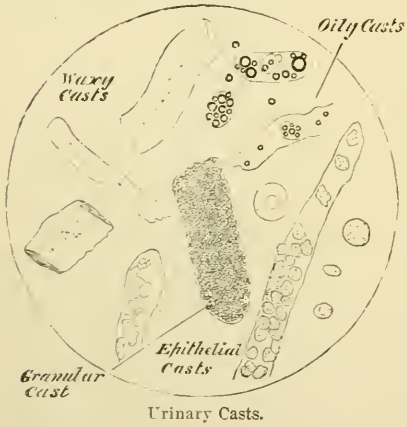
The urine, under all these circumstances, is albuminous, and the best tests for albumen are the following:

Nitric Acid Test.—To test for albumen, the urine should be boiled and enough strong nitric acid added to give the resulting liquid an acid reaction.

Any precipitate remaining after this treatment must be albumen.

A delicate mode of employing this test is to place a few drops of nitric acid in a tube and then pour the urine carefully upon it, so that the two liquids do not mix; or the reverse process may be adopted. If albumen is present, an opalescent zone will appear at the plane of contact of the fluids. If the proportion is small, several minutes may elapse before its appearance. A quantitative estimate of the amount of albumen sufficient for clinical purposes may be obtained by noting the amount of precipitate to the liquid employed, but a more accurate estimate may be formed by the use of Roberts's dilution method, described in the *Lancet*, vol. i., 1876, p. 313.

Fig. 370.



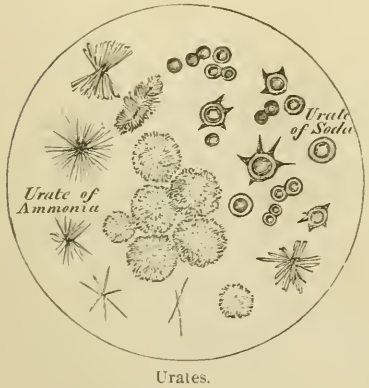
Urinary Casts.

Picric Acid Test.—This test, as recommended by Dr. G. Johnson, is used as follows: Fill a test-tube six inches long with four inches of urine, and upon this pour an inch of the picric acid solution (six or seven grains to the ounce), so as to mix only with the upper layer of the urine.

If albumen is present, a cloud or coagulum of albumen will appear as far as the yellow color of the test solution extends.

If the tube be allowed to stand, the precipitated albumen will gravitate and form a film or deposit at the junction of the colored and unstained portion of the urine. The turbid portion of the liquid must then be boiled; and if the precipitate is permanent, it must be albumen.

Fig. 371.



Urates.

Dr. Pavy's Ferrocyanide of Potassium Test, in which the Spirit Lamp is not required.—Add to the suspected urine a small quantity of a solution of citric acid. If this causes a precipitate of urates, add a little hot water, which will redissolve it; then add some solution of ferrocyanide of potassium; and if albumen is present, it will be precipitated, and nothing else, as far as is known, will.

It must be added that in all methods of testing any initial turbidity of urine from the presence of urates must be got rid of by heat. It should also be ascertained that the patient is not taking cubebs or copaiba, for all the oleo-resins are thrown down by acids. Prior boiling of the liquid will also obviate fallacy from this cause.

For bedside purposes Pavy's pellets and Oliver's test papers are trustworthy.

At times the *débris* of **kidney structure** or **cancer** products may be found.

Spermatoza (Fig. 369), **sarcinæ,** or **hydatids** may likewise be present. All these materials can be made out only by the microscope.

Urine containing **blood** is either *red* or *smoky*; that containing **bile**, dark or olive-brown. *Black* urine is commonly the result of the poisonous absorption of carbolic acid.

Pus, when poured into the urinary passage, has usually little mucus with it; that secreted by the bladder is greatly mixed with it. Purulent urine is always albuminous.

The **urates** generally appear as "brick-dust" or "red gravel" deposits. When they do so, as soon as the urine has cooled down there is generally some diminution in the watery constituents of the urine with febrile disturbance. When they are deposited some hours after micturition, increased acidity of the urine is indicated, from changes in the pigment or extractives, the acids being probably the lactic, acetic, and butyric. A drop of acid added to such urine will cause the settlement of the deposit (Fig. 371). Urates are dissolved by heat and alkalies.

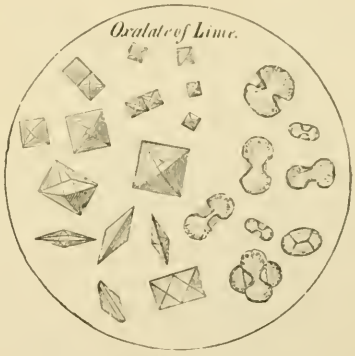
Uric acid appears in transparent urine of a yellow color and is usually deposited slowly. The crystals are variously formed, and chiefly rhombic, with the angles rounded off or lozenge-shaped (Fig. 372). They are soluble in potash or soda, but insoluble in mineral acids.

Oxalate of lime is probably secreted under the same circumstances as the uric acid and has the same pathological signification. Dr. Parkes held this view, and believed that it may be a substitution for the excretion of the carbolic acid of the lungs. It appears as octahedral crystals or dumb-bell like bodies (Fig. 373) which are insoluble in

Fig. 372.

Uric Acid.

Fig. 373.



Oxalate of Lime.

acetic acid and alkalies, though soluble in the mineral acids, such as the nitric, without effervescence.

The phosphates appear as the ammoniaco-magnesian phosphate, the phosphate of magnesia, and the phosphate of lime.

The first occurs in the form of beautiful, colorless, transparent prisms or in foliaceous or stellar prisms. It is supposed to be deposited as a consequence of the decomposition

Fig. 374.

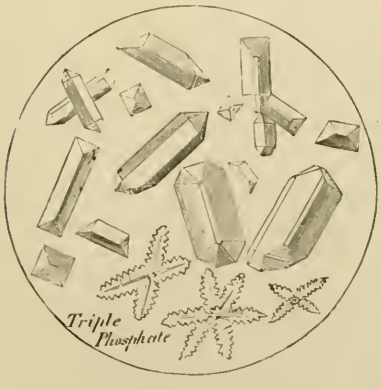
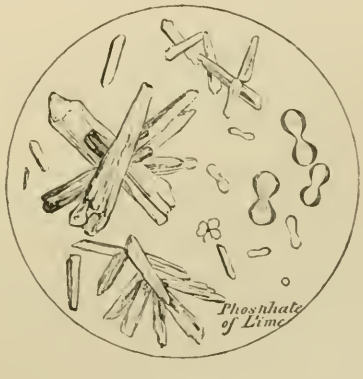


Fig. 375.

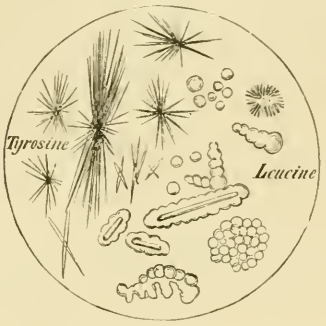


Phosphates.

of urea, and is first seen upon the surface of the urine as an iridescent pellicle (Fig. 374). It is soluble in acetic acid, but not by heat.

The phosphates of magnesia and lime occur as white gravel, usually amorphous, at times crystalline. They are mostly found in alkaline urine mixed with pus or mucus (Fig. 375). They are insoluble by heat, but soluble in acetic or the mineral acids.

Fig. 376.



Tyrosine and Leucine.

Fig. 377.

Cystine.

Tyrosine appears in the form of fine needles or stars of a greenish-yellow color (Fig. 376). When treated with nitric acid, urine containing it becomes of a deep-orange color, and on evaporation of deep-yellow. A solution of soda dropped upon this flake produces a red tinge.

Cystine occurs in colorless hexagonal plates (Fig. 377) or light fawn-colored amorphous deposit, and is soluble in ammonia and hydrochloric acid, insoluble in acetic acid.

Potash dissolves all deposits except the phosphates and oxalate of lime.

Heat dissolves only the urates of the urine.

Hydrochloric acid dissolves all except uric acid.

"Perfectly healthy urine should show no appreciable deposit; when, however, it becomes concentrated from deficiency of the watery excretion, then the uric acid is thrown down in the form of a urate. This may occasionally occur within the body, but far more frequently after the urine has been voided; sometimes, however, this change ensues so rapidly that the urine is erroneously supposed to have been passed in that condition. The presence of a solid body in any part of the urinary tract favors deposition very much, and hence urine which would otherwise remain clear may yield a deposit to any substance previously present in the same tract, and may thus add considerably to an already existing calculus. The appearance of the numerous layers so frequently seen around a central nucleus, in both renal and vesical calculi, is thus easily explained. When, however, the urine becomes further altered in composition—if, for example, a free acid is either excreted with the urine or rapidly generated in it through the setting up of the lactic fermentation—the uric acid becomes liberated from its state of combination, and in a form more or less altered by the presence of colloid matters is deposited on a previously existing calculus, or is passed as separate rhomboidal crystals or in aggregated masses, constituting gravel or sand. I should feel disposed to confine the name of 'sand' or 'gravel' exclusively to such deposits, which, I believe, seldom form the nucleus or become the starting-point of any calculus. I may add that urine possessing these characters is frequently voided for months and years without the occurrence of any appreciable inconvenience to the patient. It is true that a calculus may be augmented by contact with such urine, but, as I have said, it seldom originates in this way. Gravel or sand consists of uric acid, previously in a state of solution, which has become precipitated by the occurrence of some change in the urinary excretion." "It would, however, appear probable that the initial step in the formation of a calculus is the exudation of some colloid mucus or some other albuminoid substance into the urinary passages. Into this colloid urates or oxalate of lime, or both, are precipitated, and, combining with it, form molecular aggregations of a globular character, which constitute the foundation of the subsequent growth" (Garrod, *Lumleian Lectures*, 1883).

When any of the inorganic deposits just described mass together either by themselves upon any nucleus of organic matter, such as blood or a foreign body, a stone is the result. This stone may form in the kidney and remain there; it may pass into the bladder and be emitted with the urine or rest there and increase, or the calculus may have

its origin in the bladder, either from the precipitation of the earthy constituents of the urine or from the irritation of a foreign body introduced from without. A stone having a renal origin and resting in the bladder seems to have the power of extracting from the urine its inorganic elements and thus rapidly increasing, oxalate of lime, urate of ammonia, uric acid, phosphate of lime, or triple phosphate being precipitated by its presence and aggregating or crystallizing upon its surface. It acts, too, after a time, as a foreign body, sets up bladder irritation, and, as a consequence, the phosphatic salts are deposited, from the decomposition of the urine. Dr. Owen Rees has shown in his *Croonian Lectures* (1856) that where irritation of the bladder exists, from either a calculus, foreign body, or other cause, the mucous membrane secretes an alkaline fluid that tends to cause a precipitation of the earthy phosphates and the formation of a phosphatic deposit upon a calculus.

FIG. 378.

Renal Calculus. (Guy's Hosp. Mus., Prep. 2077ᵃ.)

Renal calculi are generally composed of uric acid, urate of ammonia, or oxalate of lime, and Beale states that microscopic renal calculi of phosphate of lime are by no means uncommon. These concretions may be either impacted in the uriniferous ducts, lodged in pouches connected with the ducts, and increase in the structure of the kidney, or pass into the pelvis of the kidney. They may be single or multiple and the size of a hemp-seed, nut, or walnut, or they may be so moulded to the divisions of the pelvis of the organ as to assume an arborescent shape such as that figured (Fig. 378). Dr. Gee has lately recorded a case in which a renal calculus weighed thirty-six and a quarter ounces (*Med.-Chir. Trans.*, 1874). There is reason also to believe that a renal, like a vesical, calculus may form upon a nucleus of blood the result of an injury.

When the stone is fixed in the structure of the kidney, its presence may be indicated by but few if any local symptoms. When it moves about in the pelvis of the kidney, it gives rise to symptoms known as those of *nephritic colic*, paroxysmal lumbar pain, with nausea, vomiting, or collapse, irritability of bladder, and at times painful micturition and hæmaturia, being the chief symptoms.

When the stone passes into the ureter, all these are aggravated, pain shooting down the groin, thigh, and scrotum of the affected side, with retraction of the testis; and these continue till the stone reaches the bladder, when a sudden relief is felt.

When calculi accumulate in the kidney and increase in size, inflammation, suppuration, and even the entire destruction, of the kidney may ensue, although it is remarkable to what an extent one kidney may be destroyed without giving rise to any symptoms. On the other hand, severe symptoms may appear for a time and subside, to reappear either months or years later or not at all. In exceptional cases a renal calculus may be discharged externally through the loin with suppuration; Dr. Cayley showed such a specimen at the Pathological Society, 1874. A stone may be impacted in the ureter and not rarely at its vesical orifice, when it will give rise to renal symptoms by obstruction, etc.

After a stone has reached the bladder it may be discharged with the urine or become fixed in the urethra and cause obstruction, or it may rest in the bladder and increase and require surgical treatment.

It is probable that most vesical calculi have a renal origin, and that some small nucleus of either uric acid or oxalate of lime forms in the kidney and passes downward into the bladder, where the urine, supersaturated with these constituents, deposits them upon the renal calculus and increases its size. Stones thus formed have been called *primary calculous formations*.

When a foreign body has been introduced into the bladder or a stone has descended into it and sets up much bladder irritation or cystitis, the phosphatic salts of the urine are deposited upon its surface; and stones thus formed are, therefore, phosphatic. When urine is retained in the bladder and decomposes, as a consequence of either cystitis following paralysis, diseased prostate, urethra, or a new growth, its earthy constituents are thrown down and phosphatic calculi or concretions are formed, such deposits being known as *secondary calculous formations*. How far these latter may increase so as to form stones is yet an open question.

All these chemical constituents, however, require to be held together by a kind of cement. "Marcet referred it to the mucous secretion of the bladder; Fourcroy and Vauquelin to albumen, and sometimes to gelatine with an admixture of urea; Berzelius, however, could not determine whether it was composed of fibrin, albumen, gaseous matter, or

mucus; Brande considered it to consist of a mixture of gelatine with urea; Scharling holds that the smaller calculi are always enveloped by a layer of mucus, albumen, or some other organic matter, the flocculi of which entangle, and ultimately determine the crystallization, of the more insoluble ingredients of the urine; and Dr. Hoskins, as quoted by Gross, extends this view to the minutest particle of the concretion" (Coulson).

Urinary calculi, says Poland, may be arranged, like the deposits, into two distinct classes. The *first* will include calculi of *uric acid* and the urates, with their modifications the oxalates, *xanthic* and cystic oxide (Dr. G. O. Rees regarding the oxalate of lime as uric acid or urates, altered after secretion); the *second*, the phosphatic calculi. A *third* class may be added, consisting of the rare calculi of carbonate of lime, the fibrinous, the uro-stealith, and the siliceous formations, other chemical ingredients being present, such as organic matters, carbonate of magnesia, silica, oxide of iron, benzoate of ammonia, oxalate of ammonia, phosphate of iron, urea, etc. The oxalates are the heaviest stones, the phosphates the lightest and largest; few exceed an ounce in weight. Coulson records one, however, over six pounds. Recent calculi contain moisture, and consequently are heavier than old. Stones vary in shape according to their position. Thus, *renal* calculi are generally irregular, often arborescent; those in the *ureter*, elongated, approaching a cylindrical form. *Bladder* calculi, when single, are more ovoid and flattened; when multiple, faceted. The mulberry stone or oxalate is always tuberculated, mostly globular, and hard; the uric acid and urate calculi, smooth and regular; the phosphatic, irregular, of odd shapes, and soft. The dumb-bell calculus is usually prostato-vesical or encysted.

The color of the layers of a calculus is due to the fact that the uric acid or urates in their deposition take with them the coloring matter of the solution from which they are deposited. All calculi, when associated with bladder irritation and ammoniacal urine, become covered with a white coating of phosphatic deposit. A stone of uric acid is usually fawn- or brown-colored; of urate of ammonia, cinder-gray; of oxalate of lime, brown or blackish-green; of xanthic or uric oxide, cinnamon-brown; of cystic oxide, a gray-greenish hue.

Phosphatic calculi, as are other forms when covered with a like deposit, are often horribly fetid and ammoniacal. They are too commonly soft and friable.

The *section* of a calculus reveals its structure, and, while some are homogeneous, the majority display concentric layers of different degrees of thickness, exceptional examples displaying fine lines radiating from their centre, of a crystalline form, which may be seen the cystine calculus (Fig. 382).

The different layers of a calculus may have the same composition or differ widely. When the latter, the calculus is known as *alternating;* but any single layer is generally composed of several ingredients. "It is probable," says Odling, "that if a very exact analysis were made, each of the layers of nearly every calculus would be found to contain uric acid, alkaline urates, phosphate of lime, and ammonio-phosphate of magnesia, with or without the other constituents of calculi. Moreover, most calculi contain traces of all the salts naturally existing in the urine, as well as coloring matter, mucus, etc."

Most calculi are divisible into a central portion, or *nucleus*, with an outer portion, or *body;* and occasionally there is an outside *crust* of phosphate (Fig. 381).

Fig. 379.

Uric Acid Calculus, with Nucleus of Oxalate of Lime. (Prep. 2193.)

The nucleus may be of the same nature or different from the body.

It may be composed of some organic material, such as blood, mucus, etc., or a foreign body introduced from without (Fig. 383).

1. **Uric acid calculus** is by far the most frequent, forming, according to Cadge, nine-tenths of all primary formations (*Address on Surgery*, 1874). It is usually derived from the kidney, and when retained in the bladder becomes a flattened oval stone of a fawn or yellow color, with a compact and occasionally crystalline laminated structure (Fig. 379). The uric acid is generally mixed with the alkaline urates in variable proportions.

This form of stone is often found in gouty subjects, and generally in the middle period of life. It is usually associated with acid urine and such as is prone to deposit the urates. The nuclei of most calculi are of this nature. In the catalogue of calculi of the Royal College of Surgeons of England (Plate IV. Fig. 6) there

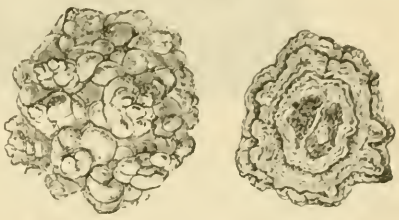
is a drawing in which a uric acid calculus is shown to have formed round a piece of steel.

2. The **urate of ammonia calculus** is not common. In Guy's Museum there are only 7 specimens of it out of 394 calculi. Most compound calculi contain this substance in abundance. They are seldom large, mostly smooth, and of a gray-fawn color. On section they are homogeneous or indistinctly laminated and have an earthy fracture. They are more commonly found in children, although they have been removed from adults. Guy's Museum contains a bottle (No. 2213) in which are 142 calculi of this nature, which Sir A. Cooper removed from the bladder of one patient. They are of the color of pipe-clay and in the form of cubes with the edges and angles rounded off.

The rarity of this form of calculus is probably due to the solubility of the salts.

3. The **oxalate of lime,** or mulberry, **calculus** stands second in point of frequency to the uric acid in European countries, though Dr. H. V. Carter tells us that the oxalate of lime ingredient predominates in all urinary calculi in Northern India (*St. George's Hospital Reports*, 1871–72). These calculi vary in color from gray to a rich brown or black and have an external form of a tuberecular, angular, or spinous character, being rarely perfectly smooth (Fig. 380). In some the surface is studded with spines so acute and slender as to resemble thorns, while in others there is a coating of acute octahedrons of transparent oxalate of lime, giving an extremely beautiful appearance. Occasionally these crystals are opaque and the octahedron is flattened, when the calculus appears as if studded with pearl-spar (Prep. 2139[5], Guy's Museum). The intervals between the spines are sometimes filled with urates or phosphates, which give the stone an ovoid form.

Fig. 380.



Mulberry Calculus. Its Section.

The section of a mulberry calculus is generally that of an imperfectly lamellated structure, the consecutive layers forming waving lines which often resemble the knotted heart of an oak (Fig. 380), but occasionally a layer of oxalate of lime is to be seen arranged around the interior one with great regularity, having a remarkably radiated appearance, like a series of infinitely minute needles placed side by side, and presenting a perfectly porcellaneous structure. In compound calculi the oxalate of lime deposit gives to the character of a stone a remarkably beautiful appearance resembling that of fortification agate.

The oxalate of lime calculi that have their origin in the kidney (and pass soon after their descent) are usually small, smooth, hemp-seed bodies.

The crystalline mulberry stone is of a pale-brown color, and, according to Dr. Yelloly, composed of nearly pure oxalate of lime. Poland had a case of this kind in which the stone on extraction crumbled to pieces from the absence of any binding material of animal matter. He gives also, on the authority of Mr. C. Williams of Norwich, an account of a pure white oxalate of lime calculus. "This," he says, "is of a milk-white color, possesses a highly-polished surface, is of extreme rarity, and is generally, if not always, found in the kidney; its external surface presents no crystals, but is perfectly smooth, though it may be spinous. In the museum of the Norwich Hospital are three specimens."

The nucleus of a mulberry stone usually contains uric acid (Fig. 381), while the body is often made up of alternate layers of uric acid and oxalate of lime. The urine is generally acid. Singular as it may appear, these rough mulberry stones rarely give rise to so much bladder irritation as the smoother forms; possibly they roll about less.

4. **Cystine** or **cystic oxide** calculus is of rare occurrence and is a formation of the kidney. Wollaston discovered it in 1810, and the second calculus which he analyzed is in Guy's Museum, and is about an inch in diameter (Fig. 382) and contains sulphur in large proportions. Poland points out its hereditary nature, since, out of 22 collected cases, 10 occurred in four families, and in these the subjects of the complaint were brothers. The calculi are generally rounded or smooth, but may be slightly tuberculated. They have a waxlike lustre and appear semi-transparent and glistening. When recent, they are of a pale yellowish-brown color, but when kept long assume a pea-green appearance. Dr. Bird remarks upon this point. "It has been suggested to me by Dr. Prout and Dr. Willis that this alteration in tint may in some way depend upon changes produced in the sulphur."

They are soft in consistence and on section present a very imperfectly radiated struc-

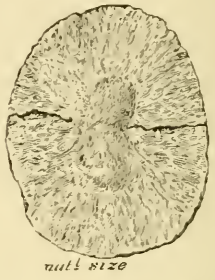
ture, with no tendency to a development of concentric layers. They yield easily to the knife when scraped and form a perfectly white powder, whether the calculus be green or brown. The fracture is crystalline.

5. **Phosphate of Lime Calculus.**—There are two varieties of this form, *the one* as described by Wollaston, of *renal* origin, consisting of neutral phosphate of lime.

FIG. 381.

Mixed Calculus.

FIG. 382.



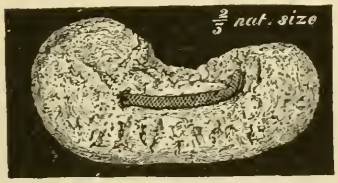
Cystic Oxide Calculus. (Guy's Mus., No. 2143.)

These usually have a smooth polished surface of a pale-brown color and are regularly laminated, the laminæ being so slightly adherent as to be easily separable into concentric crusts; in some, lines are seen radiating in a direction perpendicular to the laminæ. These calculi contain a considerable proportion of animal matter.

The other form is of *vesical* origin and composed of phosphate of lime similar to that of bones, and hence often called "bone-earth" calculi. They are more common than the former and constitute irregular masses resembling mortar or a granular, semi-crystalline powder enveloped in a tenacious mucus, these latter being more concretions than stones. There are three cases on record in which the phosphatic calculus has been followed by other forms. Foreign bodies, as a rule (and vesical calculi of long standing are such), have the earthy phosphates deposited upon them.

6. **Triple phosphate,** or ammoniaco-magnesian phosphate, **calculus** is rare. The College of Surgeons possesses but three specimens, and Guy's only two. No. 2154 in Guy's Museum shows one which has no nucleus, but a central cavity lined with delicate crystals of triple phosphate, resembling the crystals of quartz in the cavities of flints, while No. 2152 is a section of a large calculus of the kind on a nucleus of a tobacco-pipe. Fig. 383 represents such a calculus formed round a piece of broken catheter, and occurred in the practice of my friend Dr. Kitchener.

FIG. 383.



Triple Phosphate Calculus with Nucleus of a Piece of Catheter.

7. The **fusible** calculus, or the phosphate of lime with phosphate of magnesia, and ammonia calculus, is the *most frequent* of the phosphatic calculi. It is generally due to the presence of ammoniacal urine from cystitis, and constitutes the crust that forms on other calculi or on foreign bodies introduced into the bladder. These calculi increase to a large size, are irregular, and mould themselves to the position in which they are placed, often filling the bladder. Their color is white, gray, or dull yellow, their consistence friable and more earthy than any other variety, sometimes so soft as to resemble moist chalk.

Their appearance on section is thus described by Mr. Taylor in the catalogue of the calculi of the Royal College of Surgeons of England: "They are frequently composed of concentric laminæ, which in general adhere but slightly to each other; between the laminæ shining crystals of the triple phosphate are often observed; or some of the laminæ are entirely wanting, and these form a white friable mass like chalk; in others they appear semi-crystalline, as if made up of numerous small crystals confusedly aggregated together. In calculi that have a crystalline and glistening texture the triple phosphate is most abundant, while the calcareous phosphate is in excess in those which have an amorphous earthy appearance."

8. The **carbonate of lime calculus** is a very rare form. Thudichum says that prostatic calculi sometimes consist almost entirely of this substance. In Guy's Museum

(No. 2187[30]) such a vesical stone exists, of a snow-white color, with a nucleus of uric acid. Odling says that calculi which have undergone partial decomposition in the bladder often contain this ingredient.

9. The **uric** (of Liebig) or **xanthic oxide calculus**, which bears a close relation to uric acid, is as rare as the last. Dr. Marcet detected the substance in a stone of eight grains' weight, but no remains of it are at Guy's. Stromeyer rediscovered it in a stone weighing three hundred and thirty-five grains, removed by Langenbeck, which was laminated and of a bright brown color. A portion of this calculus is in Guy's Museum (No. 2145[30]).

10. The **fibrinous calculus** of Marcet and Prout requires notice, although, according to Bird, it must be regarded as a portion of dried inspissated albuminous matter exuded from an irritated kidney. Such pseudo-calculi present considerable lustre and a vitreous fracture.

11. The **uro-stealith calculus** seems to be made up of fatty matter. It has been described in Heller's *Archives* (1844–45) and by Moore in the *Dublin Quart. Journ.* for 1854. In Hunter's collection there is likewise a fine specimen of the kind.

12. **Blood calculi** have likewise been described by Marcet, and Roberts has recorded one taken from a sheep by Mr. Lund of Manchester. All recorded cases have been connected with renal hæmaturia. Silica, and also the urates of soda and lime, are occasional ingredients in a stone.

With this brief description of the varieties of stones—for much of which I am indebted to Poland's article in *Holmes's System*—it may be well to consider if any diagnosis of their nature can be made before their removal; and for this purpose the character of the urine is of great value.

If it be **acid**, the stone is either uric acid, oxalate of lime, or a mixture of the two; and, as the uric is more common than the oxalate, the probabilities point to the former. When the urine contains either ingredient, the nature of the layer that is being deposited is established.

Gouty people are more prone to uric acid than to oxalate calculi.

If the **urine be alkaline** from *fixed* alkali, as indicated by the permanent change in the test paper, the earthy phosphates or the carbonate of lime calculi are indicated; if from the *carbonate of ammonia* the result of decomposition of the urine, the mixed phosphates—that is, a crust of these is being deposited upon an unknown nucleus.

When a small stone has been previously passed and examined, great help is given toward the formation of an opinion, and also when gravel has been passed.

In England one person in one hundred thousand dies annually from stone, in Scotland one in fifty thousand, and in Ireland one in two hundred thousand. The proportion of deaths varies greatly in different districts, Cadge informing us in his very able address given before the British Med. Assoc. for 1874 that in Norfolk the mortality from stone is one in about forty-two thousand, and in Cheshire one in about four hundred and twenty-five thousand.

The bills of mortality indicate that ten males die to one female from calculous disease, and stone is said to be found in men twenty times more frequently than in women. It is probable, however, that stones form as readily in the one as in the other, but that in women, owing to the shortness of the urethra and its capability of dilatation, they are more readily discharged, large stones being not rarely discharged in the female sex by natural efforts. (*Vide* "Stone in Female.") The statistics of M. Civiale, Coulson, and Thompson indicate that about sixty per cent. of the cases of calculi are found in subjects under twenty years of age, ten or twelve per cent. in those between twenty and forty, twelve to fifteen per cent. in those between forty and sixty, and about ten to twelve per cent. above sixty. But in taking these absolute numbers and comparing them with the relative numbers of persons living at the different periods of life named, it would appear that children and young persons are less liable to calculous disorders than has been commonly supposed, and that for twenty years and upward the tendency goes on increasing in a very remarkable manner to the end of life; or, as Sir H. Thompson puts it, that the "proportion of elderly calculous patients to the existing population at their own ages is larger than the proportion of children afflicted is to the number of existing children."

Two-thirds of the cases of stone that have come under our notice in hospital practice are in children, and half of these are under five years of age. These young ones are, moreover, generally of a healthy and ruddy aspect and form a contrast to those admitted for other diseases, the formation and presence of a stone in young life being apparently not incompatible with good health.

Causes of Stone.—With respect to the causes of stone, I concur with Cadge that "it is safer to attribute lithuria to dyspepsia and malassimilation, which probably concerns all the digestive organs, than to fix the fault mainly on one," and that this condition arises from the want of milk as an ordinary article of diet; for whilst, in the children of the poor, stone in the bladder is so common as to constitute half the whole number of cases met with in practice, it is seldom seen in the more opulent classes.

STONE IN THE BLADDER.

When a stone has descended from the kidney into the bladder, it may give rise to no more marked symptom than a slight urinary irritation; and when it passes with the urinary stream, this symptom will disappear.

When the calculus rests in the bladder and increases, it usually gives rise to more characteristic symptoms, which differ widely in different subjects and apparently have little to do with the nature of the stone.

In some—indeed, in the majority—of cases the symptoms are so slight as to be disregarded, whilst in the larger number the symptoms have frequently existed for many months, if not for years, before advice is sought. Indifference or carelessness may occasionally be the cause of this delay, but, as a rule, it is due to the uncertainty of the symptoms and the comparatively little inconvenience the patient suffers. It is a rare thing, however, for a parent to seek professional advice for a child suffering with stone until *hæmaturia* has been observed, some prolapse of the rectum taken place, or the *pain* which the child experiences after micturition become pronounced, although in such a case it will generally, upon inquiry, be learnt that the child for many months had been observed to play with or drag the penis after micturition, that the stream of urine had occasionally been interrupted in its flow, and that a frequent call to make water had long existed.

These symptoms, therefore, with tolerable accuracy denote the presence of a calculus, though its existence can be positively affirmed only on its absolute detection by a sound. Yet nearly all the symptoms which have been enumerated can be produced by other and less important conditions, and more particularly by an elongated and adherent prepuce.

Retention of urine in an otherwise healthy child is almost always caused by the impaction of a stone; and when incontinence exists, it frequently indicates the presence of a calculus which has been forming for a lengthened period, and which is often connected with renal as well as vesical changes of an organic character.

In adult life indifference to early symptoms is not common, and a frequent desire to pass water, when persistent, will soon induce a man to seek advice; and, as this may be the only symptom of stone, it should be neither disregarded nor lightly treated. Indeed, with such a symptom a sound should at once be passed, this being the readiest and best means of proving whether a stone be the cause or not. The symptoms that indicate the presence of a calculus will be found to vary from the slightest irritation of the bladder to the severest agony, and those which have been described will be present in different degrees of severity or in different combinations. The importance, however, of an early detection of a calculus is so great that in every case of persistently irritable bladder which is not clearly the product of some other affection it is better to suspect the existence of a stone and examine with a sound than to run the slightest risk of overlooking it, and consequently of increasing the dangers (which are always great) of exciting or keeping up organic disease in the bladder and kidney. It is to be remembered that the presence of a calculus is dangerous to life chiefly from the organic renal changes it is liable to excite, and that neither the operation of lithotrity nor that of lithotomy is commonly fatal if such changes have not taken place. The early detection of a stone becomes, therefore, necessarily a point of the highest importance.

The confirmed symptoms of vesical calculus in the adult are pain of different degrees of intensity referred to the bladder and aggravated on any sudden movement, such as by riding, jumping, or jolting of the body, pain during, and particularly after, the act of micturition, extending along the urethra to the penis, exhausting straining, and the passage of blood. During the flow of urine a sudden arrest of the stream will often be observed, this arrest being followed after the lapse of a moment of time by the return of the flow; and this interruption may be repeated more than once in each act of micturition. Retention or incontinence of urine may complicate the case. Rectal irritation and tenesmus, with or without prolapse, are also frequent symptoms, and reflected pains along certain nerves are very constant. Thus, pain in the glans penis is most common, and pain in the scrotum, perinæum, and down the thighs is pretty constant. John Hunter

relates a case of stone in which pain in the left fore-arm was the only indication of a want to make water. Sometimes the bladder symptoms may be severe for a time and then cease, or suddenly appear after any extra exertion. In the former case the stone probably becomes fixed in a sacculus and ceases to irritate; in the latter, it escapes from a sacculus and makes its presence known. As long as the bladder remains healthy the changes in the urine will be but slight; but when the stone, acting as a foreign body, sets up cystitis, all the symptoms of that affection will appear, with the muco-purulent discharge and ammoniacal urine.

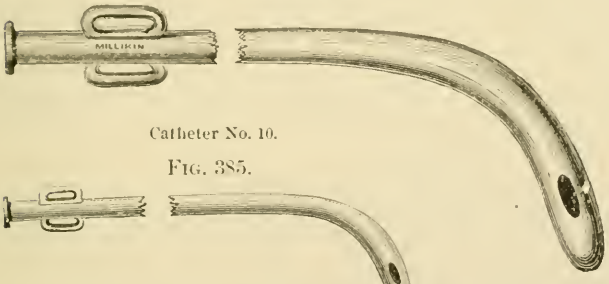
When the symptoms have existed for any lengthened period, the probabilities of renal complications are great, as indicated by albuminous urine with lumbar pain and anasarca.

In rare cases a persistent erection of the penis is present.

But these symptoms of stone are merely *subjective:* they are those given by the patient; and, however suggestive of the affection they may be, they are not conclusive, since all may be produced by other bladder affections. The only conclusive evidence to be obtained is by the physical examination of the bladder, by the "sounding" of the patient with a metallic sound or catheter, by the "ringing" of the stone against its end.

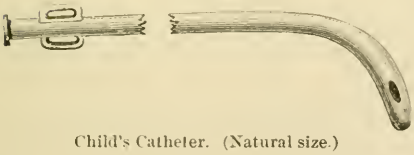
To sound a patient suspected of stone, the horizontal position should be selected and the pelvis raised on a pillow. The bladder should contain a few ounces of urine if possible, three or four being enough and eight being ample, and the rectum should be empty. When the bladder is empty, some few ounces of water should be injected. For a child a small metallic bulbous catheter or sound with a short sharp curve should be used (Fig. 385), the bulbous end being one size larger than the stem, and for the adult a similar instrument suffices (Fig. 384).

Fig. 384.



Catheter No. 10.

Fig. 385.



Child's Catheter. (Natural size.)

An instrument with a long curve may glide over the stone, and will certainly fail to find one lodged behind the prostate: it is also less movable. The shorter-curved catheter can be made to turn downward to explore the base of the bladder with the same facility as it can to explore the sides. A hollow sound or catheter is better than a solid, as a stone will often be detected on drawing off the urine, as the bladder, in the act of contracting, may throw the stone upon the end of the instrument and thus make its presence known. The catheter should not have a stylet.

The instrument should be warmed, freely oiled, and passed carefully and slowly into the bladder; nor ought its introduction to give pain. It should be at first pushed well home toward the posterior part of the organ to search its base, and then turned first to one side and then to the other to search its sides, the sound during the operation being gradually withdrawn and again pushed back. When an enlarged prostate exists and a stone is expected to lie in a pouch behind the so-called gland, the beak of the instrument must be turned backward; and in this way every corner of the bladder can be examined. When no "ring" of the calculus is first obtained, the water may be partially drawn off, and by this manœuvre it may be heard. In children the introduction of a finger into the rectum at times facilitates the search, and the pressure of the hand above the pubes often facilitates the detection of the stone.

A large stone is generally touched on the sound entering the neck of the bladder, and a small one usually lies at the base of the bladder, to either the right or the left of the median line. An encysted stone is a rarity. A stone may often be felt at one time and not at another; consequently, when well-marked symptoms exist, any hasty opinion as to its absence is to be avoided. Mr. F. L'Estrange of Dublin has invented a sounding-board to be fastened to the top of the sound for intensifying the noise produced by the instrument when it strikes a stone in the bladder. It is an ingenious instrument.

The late Mr. Napier invented a pewter sound, the surface of which, being oxidized by nitric acid, is easily scratched when coming in contact with a stone. It seems to be of use when the stone is otherwise difficult of detection. For the same purpose the microphone may possibly prove of value.

The operation of sounding ought to reveal something more, however, than the presence of the stone, such as its size and nature and whether more than one is present. The size is indicated by the extent of surface passed over by the point of the instrument; and the nature, by the noise emitted on the striking of the stone, such hard stones as the uric acid or oxalate of lime giving a sharp, clear, ringing sound, while the light and soft phosphatic calculi yield a dull one. The roughness of the oxalate of lime calculus may also be generally felt. In children, with the finger in the rectum, the size of the calculus can often be readily made out. The character of the urine, as already pointed out, throws some light upon that of the calculus. The value of chloroform in facilitating the search for a stone, more particularly in children, is so great that it should almost always be employed. In sounding, the surgeon must not be misled by the sensation given by the rugous or roughened bladder, the viscus feeling hard and uneven to the end of the sound, and the examination giving pain. When this condition is made out, all sounding should be given up; for the existence of such with a stone is almost unknown.

In children the instrument may strike against the sacrum or spine of the ischium and mislead, but in this case there is no sound emitted; indeed, the surgeon must be careful to *hear* as well as to *feel* the stone before he is satisfied as to its presence, as there are many affections of the bladder and prostate that in their clinical history and physical symptoms simulate those of stone, but in none is any perceptible sound given when using the metallic instrument, as in stone. The only unequivocal sign of calculus is the sound produced on striking the stone.

In forming a diagnosis the surgeon should always remember that when irritation at the neck of the bladder arises from stone it is referred to the glans penis; when from disease of the bladder, to the organ itself; and when from disease of the prostate, to the perinæum or rectum.

When a calculus is suspected in the female, a vaginal examination will often enable the surgeon to feel the foreign body. It will also remove all such sources of fallacy as are prone to follow from uterine affections. In female children a rectal examination will do as well.

Treatment.—A calculus having been detected in the bladder, there is only one form of treatment which can be successful, and that is its removal; for, with rare exceptions, a stone, if allowed to remain, will set up, not only bladder disease, but kidney mischief, ending in death.

A stone may be removed by a cutting operation—*lithotomy;* or by a crushing one—*lithotrity;* the treatment by *lithontriptics* and *electrolysis* has hitherto met with indifferent success.

In former times small stones were removed from the bladder by forceps. Sir B. Brodie, Sir W. Blizard, Boyer, George Bell, and others, have recorded many such cases. Sir A. Cooper's celebrated case, in which he removed eighty small stones by this means, is well known; but the practice has been entirely superseded by the lithotrite.

Lithontriptics, or stone solvents, were used long before the composition of urinary calculi had been made known, and were mostly alkaline remedies; and the most celebrated nostrum of Joanna Stephens, for which the government of 1739 gave a reward of five thousand pounds, was composed of burnt eggshells and snails, with Alicante soap. Prout showed the value of fluid as a solvent in calculous affections; Chevallier, of alkalies; and Ch. Petit, more particularly of the Vichy springs. There can be no little doubt, too, that in the lithic-acid form of stone alkalies have an undeniable influence in checking their increase, if not in aiding their solution. In other stones they have no such influence.

Dr. Roberts, who has in recent years paid much attention to this subject (*Med.-Chir. Trans.*, 1865), seems to think that "the results obtained by his experiments demand a considerable modification of the prevailing opinion regarding the inutility of the solvent treatment: they suggest an essential improvement in the treatment of *renal* calculi; they indicate that uric acid and cystine, under certain circumstances, are capable of solution in the bladder, by means of alkaline salts administered by the mouth, at a rate which admits of practical application, and that in picked cases a solvent treatment deserves to be resolutely tried." He adds, however, "that the solvent treatment is only applicable in those cases of vesical calculi in which the urine is acid, the stone not large, its composition known to be uric acid, or strongly suspected to be such." The best solvents are the acetate or citrate of potash, sufficient doses being given to make the urine *neutral*, not *alkaline*.

Garrod has suggested, as the results of experiment and experience, that as in herb-

ivorous animals the presence of hippuric acid in the urine holds uric acid in suspension, so the administration of hippuric or benzoic acid might be of use. He has found this to be the case. He gives benzoate of soda in twenty-grain doses three times a day, and continues it with some alkaline citrate if the urine be very acid. I have found this treatment very efficacious in diminishing the amount of uric acid in the urine.

Brodie showed that the injection into the bladder of a solution of nitric acid two or three minims to the ounce of water had the power of dissolving phosphatic calculi, and upon this suggestion other experimenters have tried other fluids, such as weak alkaline solutions, for uric acid calculi, carbonate of lithia, borax, and acetate of lead, etc.; but there is this great disadvantage in the practice—that the solutions are apt to irritate the bladder and thus do more harm than good. In the uric acid and oxalate of lime calculi they are almost useless. In the phosphatic stones most surgeons admit the value of the practice, a solution of diluted nitric acid ʒij to a pint of water, injected into a bladder where phosphates are being deposited, being of great value in many cases. Such a practice must, however, be carried out with great caution.

The aid of the galvanic battery has been employed to break up stones by Dr. Bence Jones, Sir W. O'Shaughnessy, and others; but the success attending the experiments has not been sufficient to warrant the recommendation of the means.

Small stones may often be washed out of the bladder by means of the urine, and patients who are prone to the passage of renal calculi into the bladder and to the formation of lithic acid or other gravel should be directed, once a day, when the full bladder is about to discharge its contents, to arrest the flow of urine by holding the penis, and then suddenly to allow the stream to flow; in this way the water, passing with a rush, carries away any small stone or sand that might be resting in the bladder. I have known this practice to be followed by good success. Old men should do this on their hands and knees. When a stone is too large to pass in this way, it must be removed, which is to be done by means of lithotomy or lithotrity.

Lithotomy or Lithotrity in Cases of Stone.

Stone in the bladder in children may be safely treated by **lithotomy**, which should be performed as soon as the stone has been detected in the bladder; for the dangers of any individual case can be fairly measured by the size of the stone and the duration of the symptoms. The longer a calculus has existed, the greater are the probabilities of renal disease complicating the case; and the dangers of lithotomy, independently of its own special risks, are mostly due to the kidney affection. When the stone is large, the neck of the bladder may be so injured by its removal as to set up a fatal peritonitis, and hemorrhage may in exceptional cases cause death; but in skilful hands the operation of lithotomy in patients under puberty is most successful.

Sir W. Fergusson informs us in his *College Lectures* that out of fifty cases of lithotomy in children, he lost only two. In my own practice, out of the same number of cases under puberty, I have lost but two. In one the stone was two ounces in weight and two inches in diameter, and the patient, ten years old, had had symptoms all his life, and incontinence of urine for four years. He died from peritonitis and extreme disorganization of the kidney. In the other the child was three years old. The stone was removed without difficulty and without bleeding, and convalescence seemed at hand, when on the seventh day secondary hemorrhage occurred, and death took place from convulsions.

In children, therefore, it may be safely asserted that success may with some confidence be looked for after lithotomy when performed with care and skill. "It may reasonably be doubted if better can be done before fifteen than cutting for stone" (Fergusson).

Lithotrity in a child, with fine instruments, may be a justifiable operation in exceptional cases when the calculus is known to be very small, but, as a rule, in patients under puberty lithotomy ought to be selected. In Great Britain this practice is generally followed by surgeons, although in France lithotrity is more frequently selected.

In stone in the bladder in adults its removal by lithotrity ought primarily to be entertained, and lithotomy had recourse to only when lithotrity is inapplicable. Lithotrity, as now practised, is, thanks to Bigelow, probably applicable to at least four-fifths of all cases of stone in adult subjects. The danger of lithotomy rapidly increases with age, the mortality being 1 in 8 between seventeen and forty, 1 in 4 above that age. I have cut 24 adult male subjects with 6 deaths, or 1 in 4; and Thompson, out of 78 cases, lost 29, or 1 in $2\frac{3}{4}$.

When renal disease can be made out as existing, lithotrity is no more favorable an

operation than lithotomy; when with it there are bladder complications, the cutting operation is probably the right one to adopt, even if only as a means of giving relief, although, when the stone is small and the renal symptoms are uncertain, lithotrity may be undertaken with success.

When *severe* bladder mischief complicates the case, lithotrity is out of the question and lithotomy should be selected, although experience confirms what C. Hawkins has stated—that lithotrity may be performed with success when the bladder has been in a very considerable state of irritation and secreting much ropy mucus. The irritation and the secretion of mucus cease when the whole of the calculus has been removed.

Paralysis of the bladder does not preclude the practice of lithotrity, though it necessitates extra care and gentleness in manipulation. An enlarged prostate, unless mechanically interfering with the introduction of the instrument, is by no means an inseparable bar to the operation.

When a severe organic urethral stricture exists, lithotrity may be impossible unless the stricture can be fully dilated. When the stone is very large, the operation of crushing may be out of question. I have, however, crushed a lithic-acid calculus one and a half inches in diameter with success.

"Formerly," wrote Aston Key (1837, *Guy's Reports*), "patients laboring under calculous disorders entertained a feeling of dread almost amounting to horror at the idea of having a stone in the bladder, but since the introduction of lithotrity they no longer entertain the dread of their symptoms depending on the presence of a stone; and when the stone is found, they cheerfully make up their minds to undergo an operation which they regard as free from danger, and nearly so from pain. I have known a patient, and more than one, to be pleased with the discovery of a stone in the bladder, convinced, as he expressed it, that he could look for an easy cure from the new operation. The exaggerated statements of the advantages of lithotrity have thus not been unattended with good; they have been the means of inducing persons to come forward to obtain relief when the disease was incipient and the stone small. Since the introduction of lithotrity the surgeon examines the bladder with great care, knowing the importance of discovering the calculus at the earliest period. The early symptoms of stone are thus watched with more jealousy on the part of the surgeon, and are not so scrupulously concealed by the patient. The advantages of an early knowledge of the existence of a stone and of prompt measures for its removal are known to both. The result of this is that patients apply for advice when the stone is small, the bladder uninjured by its presence, and the kidneys free from disease. In three persons out of four who apply for advice for symptoms of calculus, the size of the stone and the conditions of the viscus render lithotrity an easy and a safe operation."

These extracts, which I have given from Aston Key's paper written nearly fifty years ago, might have been from the pen of a more recent writer, they so accurately represent the advantages of what was then called "the new operation," and prove how the great surgeon who wrote them recognized its value. What Key would have said of Bigelow's still newer method can easily be surmised.

Summary.—It would thus appear that in *children* lithotomy ought to be the rule and lithotrity the exception, in *adults* lithotrity ought to be the rule and lithotomy the exception, the latter operation being selected only when the former is impossible from some urethral or prostatic irritability or mechanical obstruction, severe bladder disease, or a large stone. Renal disease in all cases renders doubtful the prognosis of any operative procedure, the weight of evidence tending in favor of a cutting rather than a crushing operation under such circumstances, though, when the stone is small, lithotrity is not precluded.

In cases in which neither operation can be recommended or when both are rejected it is wonderful how long patients the subjects of stone and organic disease by care and good advice will live, and how little irritation a calculus sometimes causes; and, though the knowledge of this fact should not induce a surgeon to leave alone a patient who has a stone, it is enough to enable him to give hope and encouragement to one whose life would be endangered by any surgical attempt at its removal, for palliative treatment is, doubtless, a source of great comfort and a valuable means of prolonging life.

LITHOTRITY.

"In the whole of my professional experience," says Fergusson in his *College Lectures* (1867), "I know not of a useful operation which has been so shamefully overpraised, and

thereby damaged in character, as lithotrity. I know not any process in surgery requiring more forethought, knowledge, manipulative skill, and after-judgment." "Nor is it possible," writes Thompson, "to conduct all the manipulations with too much care and gentleness." These opinions, emanating as they do from two such experienced lithotritists, ought always to be remembered, since they are true to a degree that only surgeons who have had some experience in the operation can appreciate. To Mr. Elderton, a Northampton surgeon, is due the merit of being the first to construct an instrument for the purpose of crushing a calculus and enabling the patient to pass it by the urethra (*Edin. Med. and Surg. Journal*, April, 1819), but lithotrity was first realized as an operation and successfully practised by Civiale in 1824, and to him the profession is chiefly indebted for the operation, though Leroy d'Etiolles, Heurteloup, Amussat, and others did much toward favoring the practice. It is probably, however, to Heurteloup that British surgeons are mostly indebted, as he came over to England about 1829 and fully explained to the profession the mechanism of his improved instruments and the steps of the operation, and on the invitation of Mr. Aston Key this instruction was given in the theatre of Guy's Hospital. Weiss, in 1823, had previously devised a screw lithotrite, and after Heurteloup's visit, and probably from information acquired through him, so improved it that all modern instruments are based upon that which he then introduced. Aston Key, Brodie, Costello, Hodgson, Fergusson, and others subsequently practised the operation, and through the result of their experience, with that of Civiale, the operation has become a recognized one, the instruments employed having been vastly improved and their use better understood.

In 1829, Aston Key read a paper on lithotrity at the Hunterian Society, and the report of a successful case, and in *Guy's Reports* for 1837 will be found a masterly paper upon the subject by the same surgeon. In 1834, Fergusson wrote on lithotrity in the *Edin. Med. and Surg. Journal*, in which he introduced his rack lithotrite, and to him, as well as to Sir B. Brodie, Sir H. Thompson, and Charles Hawkins, most of our modern improvements are due.

The greatest improvement, however, was left for H. J. Bigelow of Harvard, United States, who in 1878 introduced to the notice of surgeons his rapid method of crushing stones and of evacuating their *débris*, since which time, it may be said, with all truth, a new starting-point for the operation has been supplied. It is true that the full credit of this operation must not be given entirely to Bigelow, since something is due to the introduction of anæsthetics, something to the principle embodied in Crampton's bladder evacuator, introduced in 1846, and in Clover's, of a more recent period; something also to Otis, who in 1874 demonstrated the fact that the normal urethra will bear fuller dilatation than it had hitherto been subjected to; nevertheless, it was left to Bigelow to see fully the bearing of all these points, and so to focus them, as it were, upon the operation of lithotrity as to make the rapid method a positive success, the method depending upon the tolerance of the bladder, the use of large lithotrites, and, above all, the employment of large catheters and of a more powerful evacuator than Clover's. "The new and essential instrument of the operation," writes Bigelow, "is the large catheter, 25 to 31. This is indispensable. The small size of the previous evacuating catheter delayed surgical progress for half a century."

The Operation.

The objects of lithotrity may now be defined as, first, to reduce a stone to fragments sufficiently small to pass through *as large* an evacuating catheter as can be introduced into the bladder without injury to the bladder and passages; and secondly, to remove the fragments as speedily as possible.

Preliminary Treatment.—Starting with the assumption that our patient is fairly healthy, the stone of reasonable dimensions—that is, not more than one or one and a half inches in diameter—and not too hard, the urethra of normal size, the bladder capable of retaining about four ounces of not unhealthy urine—conditions under which operative interference ought to be most favorable—it is always well to keep the patient quiet for a few days, and to test the urethra and bladder as to their capabilities of bearing the mechanical irritation of large instruments by the introduction of a sound; attention should be paid at the same time to the condition of the secretions, etc. With every attention, however, it is not uncommon to meet with cases in which the mere passage of a sound is followed by severe local and constitutional disturbance, and in lithotrity such a complication is most detrimental. On the other hand, where irritability exists the occasional introduction of an instrument is often followed by relief.

When the bladder is inflamed and irritated by the presence of a stone, rest is most essential, with the use of alkalies and the decoction of the triticum repens or other drugs suitable for cystitis. When the urine is ammoniacal, the bladder should be emptied and washed out.

By these means the symptoms may subside and the bladder become capable of retaining sufficient urine—four ounces—to allow of the operation being performed where previously it would have been impossible.

Preparation for Operation.—The patient having been prepared for operation by the treatment just laid down, the bowels cleared by a mild aperient or an enema the day before, and the bladder sufficiently distended by the patient retaining his urine as long as he conveniently can before the surgeon's visit, or by the injection into it of a lotion of thymol or boracic acid, the operation may be proceeded with.

Position of Patient.—The patient should be placed upon a firm horsehair mattress or sofa, with his right side near its edge; his shoulders should be low, the pelvis raised by means of a firm pillow, and the knees slightly flexed and separated, care being taken that only such portions of the pelvis are exposed as are necessary to allow of the surgeon's manipulation; for a sudden chill often acts upon the bladder and induces it to contract and expel its contents.

The object of raising the pelvis is to roll the stone backward from the neck of the bladder, its most sensitive point.

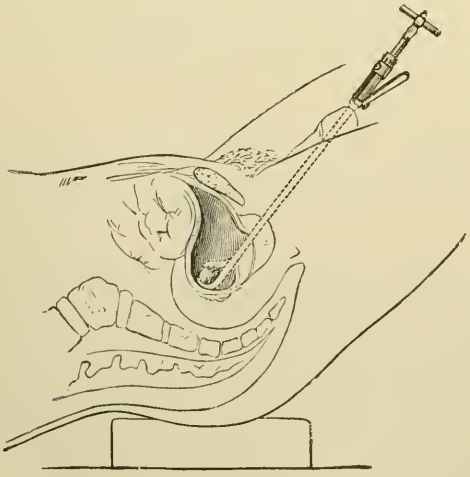
An instrument with large teeth and a fenestrated female blade is the best for crushing large stones (Fig. 388, A), and a less powerful instrument with finer teeth for small stones or fragments (Fig. 388, B).

Introduction of Instrument.—The instrument, selected by the surgeon according to the size of the stone to be crushed, having been previously well warmed and oiled, is then to be carefully introduced, no force being employed; indeed, it may almost be allowed to slide into the bladder by its own weight, the surgeon simply guiding it.

When the instrument has reached the prostate, and not before, the handle of the instrument is to be depressed toward the patient's thighs, when the blades rise up into the bladder—"a movement which is rendered more easy," says Thompson, "if a very slight lateral rotary motion is given to the instrument at this part of its progress."

The bladder thus reached and the instrument pressed well into the organ, the object is to seize the stone, which can be done either by so depressing the lithotrite with its open blades as to allow of the stone falling between them or by turning the open instrument to the stone and picking it up. The *first* is the older and the more usual method, and the one I have commonly adopted; the *second* is useful where the stone is not readily found by the first method, where the prostate is enlarged, and the stone rests in a hollow behind it. In either method the movements of the instrument are to be gentle and quiet, and care is to be observed that in opening the instrument the male blade does not injure the neck of the bladder.

FIG. 386.



Operation of Lithotrity.

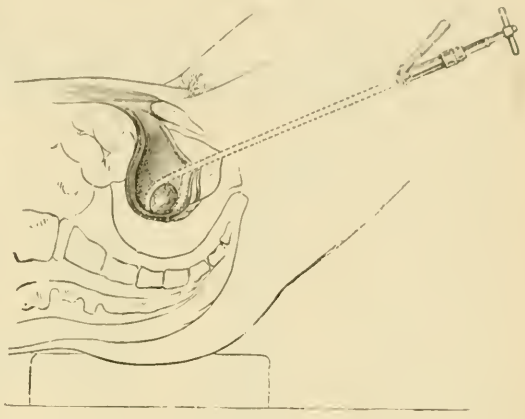
Finding and Seizing the Stone.

"Let it be understood that the blades of the lithotrite have entered the cavity of the bladder, and that the instrument slides easily and smoothly down the trigone, which in the living and healthy organ is an inclined plane, although quite otherwise in the atonied and in the dead bladder. In many cases the instrument in thus passing grazes the stone, and the slightest lateral movement of the blades, right or left, will determine on which side it lies. Whether the stone is felt or not, when the blades have passed gently down in the middle line until a very slight check to their movement is perceived, the lithotrite should rest there for three or four seconds, and then the male blade should be slowly withdrawn, without moving any other part of the instrument, toward the neck of the bladder, until a very slight check is perceived in that direction, followed by another

three or four seconds' rest for currents to subside. Now the operator should quietly press back the male blade without changing the position of the lithotrite, and almost certainly the stone will be seized. In other words, open, pause, close: that is all.

"If no stone is thus found, the operator again withdraws the male blade as before, but inclining to the right side about forty-five degrees, and closes without disturbing the central position of the instrument. If no stone is felt, he then turns them, opened, to the left in a similar manner, and then closes them. Thus, in almost all positions, the stone is seized sideways by the blades of the lithotrite, and very rarely by their extremities. Observe *that the blades are always to be opened before they are turned, for this reason: if the turn is first made and the blades are subsequently opened, the chance is that the male blade, as it is withdrawn, will move the stone away; whereas, if the blades are inclined while open, the stone, if there, is almost certainly seized.* This is one of the many apparently minute but extremely important points of which systematic lithotrity is made up. To return: it is very rare that the stone will elude the search thus far; but if it does, depress the handle of the lithotrite half an inch or so, which raises the blades very slightly from the floor of the bladder, and turn them another forty-five degrees to the left, bringing, in fact, the blades horizontally to the left; close. If unsuccessful, turn them gently to horizontal on the right, and close. In all these movements, if properly executed, there has been barely contact of the lithotrite with the vesical walls—at all events, no pressure, nothing to provoke undue pain or cause contractions of the bladder. If, however, there is an enlarged prostate, causing an eminence at the neck of the bladder or depression behind it, or the stone is very small, or we are exploring for some fragment at the close of the case which is suspected to have eluded previous search, the blade may be reversed so as to point downward to the floor, and the object sought may then often be secured with ease. If seeking for a small stone or for fragments, we may employ a lithotrite with short blades, which can therefore be reversed with much greater ease than one with long blades.

FIG. 387.



Operation of Lithotrity.

"In order to do this properly, the handle of the lithotrite is depressed another inch or so between the patient's thighs, so that the shaft of the instrument, instead of being directed a little upward, is level with or points below the horizon; the blades, being still closed, are cautiously brought round to the reversed position and the floor first lightly swept in the manner of a sound in searching for stone. Then they may be carefully opened and closed two or three times in slightly varied directions, but without injuring the floor of the bladder. When the prostate is considerably enlarged and a stone or fragments have to be sought behind it, the lithotrite is reversed without depressing the handle.

"All these movements are to be executed at or beyond the centre of the vesical cavity, the proper area for operating, without hurry, rapid movement, or any other which partakes of the nature of a jerk or concussion, and, if in a fairly healthy bladder, without causing more than a very slight degree of pain to the patient. The operator's eye is also to be so familiar with the scale marked on the sliding rod that he knows at a glance the exact interval which it indicates as existing between the blades in the bladder. It is essential to good practice, while manipulating the lithotrite, to maintain the axis of the instrument as far as possible always in the same direction. The blades only are to be moved; the shaft should occupy the same inclination, unless when this is intentionally altered. In screwing home the small blade the operator is very apt to move the lithotrite also at each turn of the screw, unless he is conscious of the care necessary to avoid the evil. *All lateral movements, all vibration and concussion, necessarily tell on the neck of the bladder and prostatic urethra*, where the instrument is most closely embraced and its mobility is most limited. To that part of the lithotrite which occupies the anterior portion of the urethra much freedom of lateral movement is permitted, and in the bladder the instrument is free, although in a less degree; but the axis or fixed point, as regards

lateral movement, is at the part indicated, which is also the most sensitive spot of the entire passage. Hence the aim of the operator should be to produce in this situation no motion of the lithotrite except that on its own axis. Few of the details of the operation require more practice to master than this.

"A rule has been laid down with reference to the situation of a calculus in the bladder. It is said that the larger the stone, the more certain is it to be found lying near to the neck of the bladder in the ordinary recumbent position, while a small one is usually detected at the back of the trigone. Without assenting to the accuracy of this remark—at all events, in relation to the small stone, which is often close to the vesical orifice—it may be said here that the act of seizing a large stone in this position requires consideration; for if the operator commences by withdrawing the male blade according to the ordinary custom, this blade is apt to be drawn against a large stone, which it therefore fails to catch, and presses it back against the neck of the bladder, doing mischief and not succeeding. As a general rule, it may be said that the most common cause of failure to seize a large stone arises from its close proximity to the neck of the bladder (whatever position is given to the patient) and from the male blade being drawn up against it at each opening of the lithotrite in the manner just described. In these circumstances the operator feels the contact of the stone without suspecting its precise locality each time he withdraws the blade, and is apt to feel embarrassed on failing to seize it when he closes immediately after. In these cases it is essential to draw the male blade gently, but closely, to the neck of the bladder, and to slide the blade between the neck and the stone which lies in contact with it."

"The rules laid down for finding and seizing apply more or less to lithotrites of moderate size, but this general rule may be borne in mind: viz., the more powerful the lithotrite—that is, the larger and longer are its blades—the less readily are we to adopt the reversed positions of the blades and the more fluid is it desirable to have in the bladder. As large and fenestrated blades are used chiefly for the initial act of breaking up a large stone into fragments, it is obvious, also, that there is less occasion for the horizontal and reversed movements, since a large stone may almost certainly be seized by the right or left incline."

Crushing the Stone.—"Supposing that a hard stone of an inch and a half in diameter has fallen into the grasp of a powerful lithotrite, the screw is to be gradually turned at first, to make the blades bite, since a sharp turn at this moment may drive the stone out either right or left. As the power is increased the resistance is felt to relax, sometimes by degrees, sometimes suddenly with a crack, and the stone is broken usually into four or five large pieces, besides some small *débris*. This done, the male blade is again drawn out, taking care not to shift the situation or alter the axis of the lithotrite, and almost certainly one of the large fragments will be picked up. It is then only necessary to screw home, release the screw, and open as before. This process may be repeated several times at the same spot, for the area within which the larger fragments fall is very limited and is unchanged if all remains quiet. The large and heavy pieces fall invariably in the same place, and may be picked up again and again if *this simple rule of keeping the* blades in one place is adhered to. Having now broken up the stone and crushed well the largest fragments, and thus occupied perhaps from ten to fifteen minutes, it should be time to employ the aspirator and remove the *débris*. Accordingly, the screw of the lithotrite is driven well home, to close the blades, between which some calculous matter probably is engaged, and the lithotrite is withdrawn."

Removal of Debris of Stone.—The stone, having been crushed, has to be removed; and this is effected by means of a large catheter and powerful evacuation.

A No. 15 or 16 evacuating catheter for small, and a No. 17 or 18 for large, stones should be selected and passed, the larger instruments, Nos. 25 to 30, as used by Bigelow, being required in very exceptional instances, the size being determined by that of the urethra. These are made of different curves (Fig. 388, C). The urine should then be withdrawn.

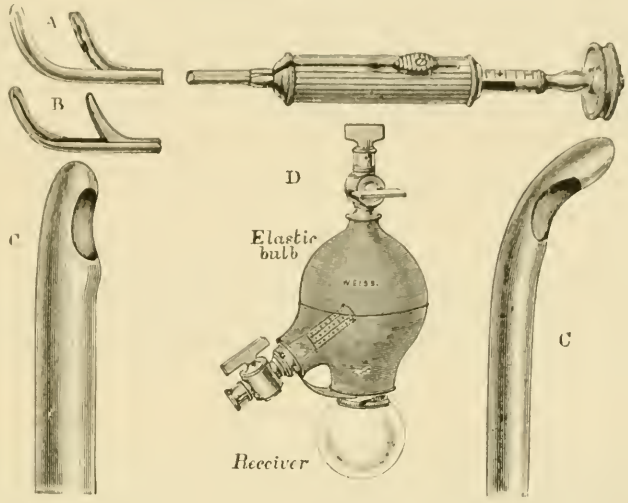
"An aspirator (Fig. 388, D), previously filled with tepid water, is then attached, the connection tap opened, and a small portion of its contents pressed by the right hand into the bladder, the left hand supporting and directing the evacuating catheter."

"On relaxing the pressure an immediate current outward follows, carrying with it, very probably, a fair quantity of *débris*. Wait some three or four seconds after expansion has finished and the current apparently ceased, as at that precise time it is quite common for one or two of the larger fragments to drop into the receiver which would have been driven back, perhaps, by too rapidly resuming the pressure. This process is

repeated several times, according to the amount of *débris* observed to enter the trap. After a large crushing the end of the evacuating catheter should not rest on the floor of the bladder, as it is then likely to be choked with *débris*; but after most of the fragments have been removed it is advantageous to lower the end of the catheter, in order to catch the last fragments.

"If the outflow of the current is felt to be suddenly checked and the aspirator ceases to distend, the operator may be almost certain that a fragment of a rounded or cubical

FIG. 388.



Lithotrites, Catheters, and Evacuator required for Bigelow's Rapid Lithotrity.

form or a small calculus, nearly fitting the interior of the catheter, blocks the passage and prevents further egress. The piece must be expelled by making smart pressure on the india-rubber bottle, after which the action of the aspirator will probably be resumed.

"If, after crushing all the stone, so far as the operator is able to judge, and removing the *débris* largely, nothing is heard or felt in contact with the end of the evacuating catheters, notwithstanding that three or four successive pressures have been made, there is ground for believing that all the fragments may now have been removed. Perhaps there can be no better proof that the bladder has been emptied than is afforded by the fact that a succession of outward and inward currents through the aspirator shows no sign either to the eye or to the ear of the presence of another fragment.

"If all has not been removed, the sound of a large piece, perhaps making itself heard and felt at each outward current against the end of the catheter, indicates that this must be withdrawn and a lithotrite introduced. If the fragments are not of considerable size, a lighter and handier lithotrite may succeed with advantage to the heavy fenestrated one originally used, and the crushing continued. Of course, if more stone remains, the process is repeated once or more. In from ten to forty or fifty minutes, however, a uric-acid calculus of very considerable size may be thus broken up and removed."

AFTER-TREATMENT.—When the patient has fully recovered from the anæsthetic, if suffering severely say three or four hours after the operation—a condition, by the way, which is very uncommon—a hot bath, as hot as he can have it, for fifteen minutes, gives great relief. The treatment for the first three or four days in cases of large calculus is that of a mild acute cystitis—recumbent position, external warmth, frequent hip baths, and small but frequent doses of solution of potash, just to neutralize the acidity of the urine. If the urethra is overstretched or bruised, an india-rubber catheter may be tied in for twenty-four hours or so, but this is not frequently necessary; while if the bladder had previously lost the power of emptying itself, such an inlying catheter for a day or two is mostly better than frequent catheterism."

"As a general rule, we find, during the three or four days immediately following the operation, that the relief is considerable, that the urine is clear, that the bladder tolerates a large quantity, and the aspect of the case is one of rapid and unchecked convalescence. But on the fourth or fifth day a little excitement is not infrequently observed: the blad-

der becomes irritable, the urine is cloudy, and after twenty-four hours or so subacute cystitis is established, often destined to be troublesome for a week or two. This liability indicates that it is most desirable to enforce the recumbent position, confinement to the room, a warm temperature (in cold weather), and care in every particular of management for at least some days after crushing a calculus, whatever its size."

Complications.—When a fragment becomes impacted in the urethra and produces retention, it should either be gently pushed back into the bladder with a large catheter or removed with urethral forceps. These fragments not only produce retention at times, but epididymitis, from irritation of the caput gallinaginis.

Should fever follow the operation, ushered in with a rigor, there is probably some slight lesion of the urethra. "In nine cases out of ten it is not of serious import, and is treated by keeping the patient warm, wrapping him up well, applying hot bottles, and giving some warm drink, as hot tea or warm wine and water." A moderate dose of opium is perhaps the most useful prophylactic.

Occasionally the attack of fever announces the onset of a cystitis, testitis, or some renal complication.

Hemorrhage is a rare complication. When present, by rest and cold it usually subsides.

Chronic retention of urine is a complication which is to be carefully looked for, since it occurs very insiduously; it is to be relieved by careful catheterism.

Sir H. Thompson reports that he has had 104 consecutive cases of rapid lithotrity in men averaging sixty-two years of age, with only three deaths. This mortality, he adds, "is a better achievement than I had ever ventured to hope for" (*Holmes's System*, 3d edition, vol. iii.).

LITHOTOMY.

In children where lithotrity is inapplicable, and in adults when lithotrity, for reasons already given, ought not or cannot be applied, lithotomy *must* be employed; and lateral lithotomy is doubtless the best, as it is the most usual, operation. "In children it is difficult to mention any operation in surgery so uniformly successful as lithotomy is. The incomplete development, and the consequently little susceptibility, of the parts involved, the small size of the vessels and the little risk of hemorrhage, the yielding nature of the textures, rendering force unnecessary in the extraction of the stone, are circumstances that combine to divest the operation of much of the danger that surrounds it when performed in the adult. From childhood to the age of puberty the dangers can hardly be said to increase. Boys of thirteen years of age suffer scarcely more from the operation than children, and for the same reason. Seeing, then, that so little risk and suffering attends lithotomy in children, it is difficult for us to find an equally safe and efficient substitute; it can scarcely, indeed, be said to be required" (Aston Key).

In the adult male lithotomy is rarely resorted to until the surgeon becomes convinced that the removal of the stone by lithotrity is inapplicable or has failed; at least such has been the practice at Guy's Hospital for many years, and, taking the average of cases of stone in the adult admitted, half only have been subjected to lithotomy. In private practice the proportion of cases of lithotomy to lithotrity is much smaller, patients applying for advice at an earlier period. From this fact the worst cases of stone are alone submitted to the cutting operation, and, as a consequence, the mortality is high. At Guy's lithotrity being the rule in adults and lithotomy the exception, the mortality of the latter operation in adults is one in three, whereas in places where lithotrity is little practised it is one in five.

"It is probable," writes Birkett (*Guy's Rep.*, 1867), "that the rate of mortality after lithotomy must henceforth always appear higher than formerly, in consequence of so many of the patients suffering with stone who might have been cut successfully being those now selected for the performance of lithotrity. In point of fact, the very cases which swelled the list of successful results no longer appear in the category of those submitted to the cutting operation; but, on the contrary, those patients too ill to recover from lithotrity frequently, as a last resource, submit to lithotomy and perish."

Lateral lithotomy, or the operation of Raw, Jaques, and Cheselden, is, without doubt, the favorite means of extracting a stone from the bladder among modern surgeons, assuming that lithotrity is inapplicable or inadvisable. As an operation it has been nobly planned, and to see it performed with skill and precision is still a sight which affords gratification to the youngest as well as to the oldest surgeon. In my student days to see Aston Key cut for stone was an event which I now fondly think over with pleasure and

admiration, and the memory of the skill and precision of his acts in this as in all other operations is still before me as a standard of perfection at which all should aim.

These remarks are not inapplicable as a preface to the subject of lateral lithotomy, for Key's use and advocacy of the straight staff in that operation have so influenced all his successors that up to the present day "Key's" operation is the one usually performed at Guy's, the exceptions to this rule being so rare as not to be named. The success which has attended this practice has been very good; when, indeed, compared with that furnished from other sources, it seems so remarkable that it is difficult to arrive at any other conclusion than that the mode of operation has something to do with it, for, taking the most reliable statistics—the Norwich 408 cases in subjects under puberty, and Thompson's 868, eliminating the Guy's cases—the mortality was 1 in every 14½ cases; whilst of Guy's cases and Key's operation during seventeen years it was 1 in 57 cases, 3 deaths only having occurred in 171 cases, the success of Key's operation being four times greater than that of others.

In children under five years of age these points are still more strongly marked, as, out of 400 cases tabulated by Thompson, the mortality was 1 in every 13½, the Norwich not being quite so good; whilst at Guy's after Key's operation, in my old table it was 1 in 23½ out of 73 cases, and *more recently, during seventeen years, ending in 1874, 100 patients have been cut consecutively without a death.*

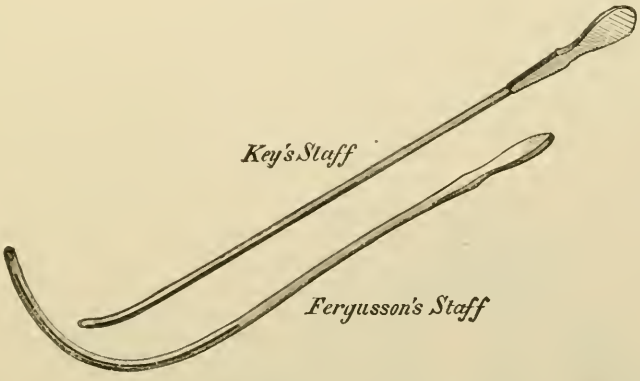
In the nine years ending 1882 the results were not quite so good, as one child, æt. 3, died on the fifth day from convulsions after secondary hemorrhage when he was thought to have been convalescent, out of 15 cases operated upon.

This success is certainly more striking than I anticipated when I began the comparison, and must in a measure, if not altogether, be ascribed to the greater safety of Key's operation.

I propose now to describe the operation of lateral lithotomy, and I shall do so after what I believe to be the best method—that of "Key," giving also that with the curved staff. But first of all as to the instruments required.

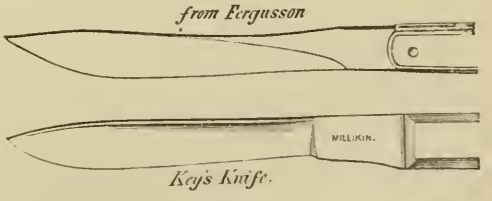
The **staff,** whether straight, as in Key's operation, curved (Fig. 389), or rectangular, as in others, must be regarded as a director. It is a means the surgeon employs to guide

FIG. 389.



his knife into the bladder, and I may say with Key that "the advantage of a straight over a curved line as a conductor to a cutting instrument is too obvious to require any comment. Is it surprising that the blind should err in a crooked path?" Key's staff is blunt-pointed as a sound and more deeply grooved than the common staff, to prevent the risk of the knife slipping out; the groove is in the centre of the staff, not at one side, as in the ordinary curved one, and it runs to within half an inch of the end. "Its chief superiority," writes Key, "consists in allowing the surgeon to turn the groove in any direction he may wish."

FIG. 390.



The staff must vary in length and size, according to the age of the patient and size of the urethra, it being well to use as large a one as will pass readily down the urethra.

The **knife** varies much with the fancy of the operator. That employed by Key (Fig. 390) and his successors resembles in form a common scalpel, but is longer in the blade and slightly convex in the back near the point to enable it to run with more facility in the groove of the director. Different sizes are required for a child and an adult.

The knife as employed by Sir W. Fergusson (Fig. 390) is given as a type of that required for the curved staff.

A **probe-pointed bistoury** or blade with a round point is sometimes of use to enlarge the vesical opening when not made free enough or to give vent to a large stone.

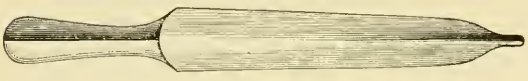
Lithotomy forceps should be made of several shapes and sizes, and a scoop (Fig. 391) ought also to be at hand. It is used by passing it behind the stone and fixing it there by the pressure of the left index finger, the instrument with the two hands being withdrawn with the stone.

Fig. 391.

Lithotomy Scoop.

When the perinæum is very deep and some extra guide is required by the surgeon for the introduction of his forceps into the bladder and the extraction of the stone, the **blunt gorget** (Fig. 392) may be used, the instrument, guided by its beak, being passed into the bladder upon the staff, and upon this the forceps can readily be introduced.

Fig. 392.



The Blunt Gorget.

The gorget is never needed in children, but in adults it is often of great use.

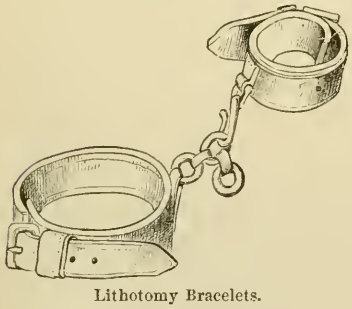
Preparation for Operation.—The bowels should be well cleared out by a dose of castor oil, given some hours previously, and the rectum emptied by means of an enema the morning of the operation, care being taken that the enema has returned. The perinæum should likewise be shaved.

The Operation.

The surgeon, having decided upon his operation, selected his instruments, and seen that he has at hand everything he may require, having also obtained the help of three, if not four, assistants, besides the anæsthetist, proceeds to place his patient.

A narrow but well-raised table should be employed, so that the patient's perinæum and the surgeon's face should be nearly on the same level. The patient should be placed on his back with his thighs flexed upon the pelvis and the legs upon the thighs, the hands of the patient being made to grasp his feet and fastened in such a position by the figure-of-8 bandage, the padded bracelets and anklets, as seen in Fig. 393, or Clover's crutch. Children need not be fastened, but it is more prudent for adults, although some surgeons, since the introduction of anæsthetics, have given up the practice under all circumstances. The shoulders should be well raised, the knees separated, and the pelvis kept well down upon the table by two assistants; the surgeon should also see that the patient is quite straight, the line of the umbilicus being the best guide to this position. *The perinæum should be perpendicular.* The surgeon may then pass the staff, and, having introduced it well into the bladder and felt *as well as heard* the stone, he is to entrust it to the hands of an assistant —one who can confidently be relied upon to hold it in the position in which the surgeon has placed it and who will not draw it forward in any degree. This point is of importance, for there is good reason to believe that many of the mishaps connected with the operation are due to the staff having been partially withdrawn from the bladder by an assistant, who perhaps in stooping forward tries to get a sight of the operator's movements.

Fig. 393.



Lithotomy Bracelets.

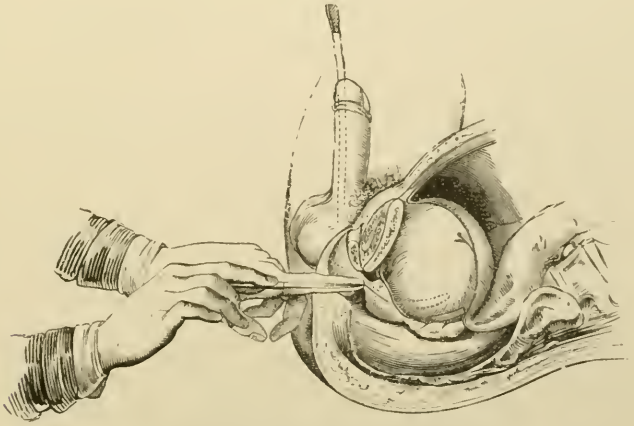
When the straight staff is used, it is to be held well up, with the handle slightly tilted toward the operator; and when the curved staff is employed, some surgeons like it to be well hooked up against the symphysis; but under all circumstances it is to be held steadily.

First Step.—The surgeon, having ascertained the size of the prostate through an anal examination, may then proceed with the *first step* of the operation—viz., to lay bare the staff or director that is to guide his knife into the bladder; and the point at which this opening is desired is *at the membranous portion behind the bulb and in front of the prostate.* Blizard, Martineau, Stanley, Key, and Fergusson all lay stress upon this important point. With this view the perineal incision is to be made, and in lateral lithotomy the line of incision lies from the left of the median line of the perinæum downward, backward, and outward, midway between the anus and the left tuber ischii. The incision is usually from three to three and a half inches long. Some surgeons commence the cut an inch in front of the anus, others fix it at one and a quarter to one and three-quarters; but this point is not one of primary importance. The object of the incision is to make a free external opening, to enable the surgeon to reach the groove of the staff at the part indicated and allow subsequently of the removal of the stone; a point midway between the scrotum and anus is probably the best to start from, the length of the perineal region varying greatly in different subjects.

In making this perineal incision the left thumb of the operator should be firmly fixed above the point at which the knife is to be introduced, and it is well for the surgeon with the left fingers to hold the staff firmly at the root of the penis at the same time. The point of the knife may be well introduced into the soft parts in the line of the director and the tissues freely divided in the cut downward, a second or third touch of the knife being made to complete the section. If these be made too low, the rectum is liable to be wounded. In this incision the perineal triangle and ischio-rectal space are laid open, and the skin and fascia with the transverse perineal muscle and its artery divided.

Second Step.—The surgeon, having exposed the groove of the director (staff) that is to guide his knife into the bladder, should then proceed to the *second step* of the operation. For this purpose, when the curved staff is used, he should introduce the forefinger of his left hand into the wound and feel for the staff *behind and to the left of the bulb, and, having clearly made out the two edges of the groove and run his nail between them*, he should introduce the point of his knife upon the nail of the finger into the groove, and, having clearly divided the tissues sufficiently to make him confident that the point of the knife is well into the groove of the staff, complete his deep section by pushing the knife along the groove of the staff into the bladder, lateralizing it to divide the left lobe of the prostate and neck of the bladder sufficiently (Fig. 394). "The point of the knife in Key's

FIG. 394.



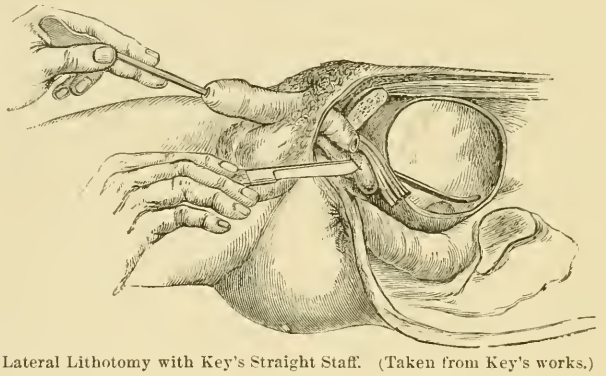
Lateral Lithotomy with a Curved Staff.

operation being kept steadily against the groove, the operator with his left hand takes the handle of the director and lowers it till he brings the handle to the elevation described in Fig. 395, keeping his right hand fixed; then with an easy, simultaneous movement of both hands the groove of the director and the edge of the knife are to be turned obliquely toward the patient's left side; the knife, having the proper bearing, is now ready for the section of the prostate; at this time the operator should look to the exact line the director takes, in order to carry the knife safely and slowly along the groove, which may now be done without any risk of the point slipping out" (Key).

"In the majority of cases it will merely be necessary to pass the knife along the

director, and, having cut the prostate, to withdraw it, without carrying it out of the groove, varying the angle according to the age of the patient, the width of the pelvis, and size of the stone. As the direction in which the prostate should be divided, in order

FIG. 395.



Lateral Lithotomy with Key's Straight Staff. (Taken from Key's works.)

to adhere to Cheselden's operation, is obliquely downward and outward, increasing the angle at which the knife enters the bladder will incur no risk of wounding the pubic artery. The knife may be conducted with deliberate care into the bladder; the resistance afforded by the prostate will be readily felt, and the hand of the operator should be checked as soon as he feels the prostate has given way" (Key).

The surgeon knows when he has entered the bladder by the absence of resistance, and occasionally by a rush of urine. He should remember, however, that some urine will escape so soon as the urethra has been opened, and not be misled by the fact. The angle which the knife makes with the staff regulates the size of the incision into the neck of the bladder. When the knife is in a line with the staff, the incision will be limited; the larger the angle the knife makes with the staff, the larger will be the wound.

As a rule, a large wound can be of no advantage unless the stone is very large. A small wound, however, is a disadvantage when the stone is of medium size; for, although the neck of the bladder is capable of a good deal of dilatation under moderate force, any severe laceration of the prostate is almost certain to be followed by bad results. Surgeons differ much upon this point, some recommending dilatation in preference to free incisions into the neck of the bladder, whilst others prefer free division of tissues rather than run the risk of lacerating them.

Moderate dilatation is certainly free from risk, while severe dilatation is dangerous, inasmuch as it necessitates great laceration. As a rule, the incision should never exceed the limits of the prostate.

Third Step.—The bladder having been opened, the third step of the operation remains to be performed, which consists in the removal of the stone. This is to be done by means of forceps.

The knife having been withdrawn on the completion of the second step, the index finger of the surgeon's *left* hand, guided by the staff, should be introduced through the wound into the bladder; and the operator ought always to remember that *till the finger has been fairly passed into the bladder upon the staff, this instrument is not to be withdrawn*, although, when the bladder cannot be reached by the finger, the blunt gorget may be passed along the staff, to act as a guide to the forceps. The forceps, held in the surgeon's right hand, is then passed into the wound upon the left index finger, and, guided by it, pushed into the opening, the forceps being introduced into the bladder at the moment the finger is withdrawn.

"Having delivered his knife to the assistant, the operator, in 'Key's' operation, takes the staff in his right hand, and, passing the forefinger of his left along the director through the opening in the prostate, withdraws the director, and, exchanging it for the forceps, passes the latter upon his finger into the cavity of the bladder."

"In extracting the calculus, should the aperture in the prostate prove too small and a great degree of violence be required to make it pass through the opening, it is advisable always to dilate with the knife rather than expose the patient to the inevitable danger consequent on laceration" (Key).

The forceps should be full-sized and introduced into the bladder closed *flat upon the*

stone, and immediately opened, the stone generally being at once caught in the blades, the rush of urine carrying it toward the wound. The stone should be grasped boldly, and when seized be slowly and deliberately extracted, the extracting force being made in the direction of the axis of the pelvis *downward* and backward and then forward; a little rotatory and side-to-side motion of the instrument at times facilitates the extraction of a calculus, the surgeon at the same time, with his index finger, pushing the soft parts off the stone. Before extracting, the operator, by the sensation given to the forceps, will assure himself that the bladder is not caught.

It is in this third step of the operation that the surgeon frequently meets with his difficulties, and much discretion and fertility of resource is often needed to overcome them, since no definite rules can be laid down as a guide. The stone may elude the grasp of his instrument; sometimes it clings to the bladder above the wound behind the symphysis, and is thus without the reach of the instrument; at others it is caught above, under which circumstances the pressure of the hand of an assistant above the pubes becomes of value, or the injection of a stream of water is advantageous. Occasionally, although rarely, the stone may be encysted. At times, when the stone is very small, it may be washed out with the first rush of urine, and consequently not felt. I have seen this happen in a child. At times a bladder may be opened and no stone found; "but from all my experience," writes Sir W. Fergusson, "I feel justified in stating my conviction that most of the cases heretofore related as instances where the incisions for lithotomy have been made, and a stone has not been present, have been examples where the surgeon has failed to reach the bladder." In children this is particularly the case, the surgeon pushing the bladder inward off the staff. This accident is liable to occur when the neck of the bladder is not sufficiently opened.

After the removal of the stone the finger or sound should be introduced into the bladder, to ascertain the existence or non-existence of a second stone.

After-Treatment.—As soon as the operation has been completed the patient should be unbound and any bleeding vessels twisted. In children the introduction into the wound of a piece of ice or the application to the wound of a cold sponge, with or without ice, is usually enough to arrest any hemorrhage, and in the adult the same practice, as a rule, suffices. When, however, the hemorrhage is persistent, a piece of sponge or a sponge tent should be introduced into the wound up to the neck of the bladder; such a proceeding arrests bleeding, though not the flow of urine, which percolates through the sponge. The sponge may be removed at the end of twenty-four hours.

Liston was in the habit of introducing a gum-elastic tube six inches long through the wound into the bladder, to carry off the urine for the first two days, and fastening it in with tapes. This practice is still followed by some. It is, however, quite unnecessary; and at Guy's we use the tube only in exceptional cases—that is, when severe hemorrhage ensues, the wound being plugged around it. Dupuytren employed a tube to which was attached a circular piece of oil silk at its centre, like an unribbed umbrella; sponge or charpie was introduced between the tube and silk when bleeding took place, after the upper end of the tube had been introduced through the wound into the bladder. Matthews has adapted an india-rubber bag around the tube, which can be introduced into the bladder empty and then expanded with air and water. It answers the same purpose as Dupuytren's *canule à chemise*, and is probably more efficient.

In exceptional cases, when the bulb is cut into, it may be necessary to apply pressure with the finger on the pudic artery to arrest bleeding.

The patient having been placed in a bed, a good draw sheet should be placed beneath his hips and a pillow behind his knees, to keep them flexed, while the knees *should not be tied together*. A sedative may be employed to give rest, but beyond this little or no medical treatment is required. The diet should be nutritious, but unstimulating, and wine and meat given as soon as the appetite demands. The bowels, if not acting naturally on the fifth or sixth day, should be cleared by an enema or mild aperient such as castor oil, and the horizontal position should be maintained till the wound has closed. Key has remarked that in children partial incontinence is apt to follow when this rule has not been observed.

Sources of Difficulty in Lithotomy, and how to Avoid them.

The difficulties connected with the operation are too often due to carelessness and too great speed; consequently, they are mostly of the surgeon's own making.

If, however, he *feels the stone* and *hears its ring* before operating, he is sure of its

presence, and knows also that the staff is in the bladder, and that it has not passed through any false passage in the urethra or between the bladder and rectum. If, moreover, *before* cutting, he assures himself by touching the staff that it has not been displaced, he has a direct guide down to the calculus.

If *when* cutting after having exposed the groove of the staff, and then proceeding to the second step of the operation, he feels the *two borders* of the *groove* with the nail of his left index finger, and with certainty cuts between them *into* the groove, he will be still sure of his guide into the bladder, and not likely to fall into the not uncommon error of mistaking the side of the staff for the groove, and thus going astray.

If, again, when running his knife down the director into the bladder, he pushes it sufficiently far as to feel all resistance cease and for urine to flow, he may be certain that the bladder has been opened. And if, on introducing his finger into the bladder, "he never pushes the point of his forefinger onward unless he feels certain that he has it between the staff and the wound," he is not likely to make a cavity with his finger in the cellular tissue outside the bladder or to push the bladder off the end of the staff; and if he never removes the director or staff till his finger or gorget has been introduced into the bladder as a guide to his forceps, he is still free from error.

In the last step he has only to handle his forceps boldly to grasp the stone fully, and in extracting it *always to draw downward and backward*, with some rotation, and he will complete his operation without a mishap.

The external wound should always be free, the internal limited, moderate dilatation of the neck of the bladder being free from harm.

If in operating the surgeon lose his guide, from the end of the staff slipping out of the bladder, and he be unable to effect its reintroduction, or if by some error he has missed the staff and allowed his knife to travel by its side, and thus failed to find the bladder, it is better to relinquish the operation, let the wound heal, and operate again; for without the guide of the director the operation is an impossibility and all manipulation hazardous. But so long as the staff is in the bladder errors may be corrected and the operation completed, for by the reintroduction of the knife along the groove an opening into the neck of the bladder that has been made so small as to forbid the introduction of the finger may be enlarged, even when the neck of the bladder has been pushed backward and the finger seems about to travel into an unknown region.

Should the *rectum* receive a *small* wound during the operation, it may be disregarded, as it is rarely followed by any injurious effect; and even when the wound is large, it is well, perhaps, to leave the case to nature. Should it not heal, the case may have to be dealt with as one of fistula in ano, by division of the sphincter.

At times the walls of the rectum, *after* the operation, may slough from the injury they sustained during the removal of the stone, but such cases usually do well when left alone. In my own practice this sloughing took place after the extraction of a large mulberry calculus, but the case did very well, nor was the recovery tedious.

Prostatic enlargement may be a cause of difficulty in the operation in elderly patients; and when with this enlargement there is rigidity, the difficulties are increased, for the surgeon, under these circumstances, in order to make a sufficient opening into the bladder, may have to travel far into the pelvis upon the staff; and when the bladder is opened, he may be unable, on account of its depth, to reach it with his finger. Under these circumstances the blunt gorget becomes of great value, as it can readily be run along the straight or curved staff into the bladder and form a certain guide to the introduction of the forceps. Martineau was very fond of the blunt gorget in most cases, and I am tempted to think that in adult subjects it might now be used more frequently with advantage. I have found the greatest benefit from its use in several cases.

When the prostatic enlargement encroaches on the bladder, the vesical lobe may be lacerated by the blades of the forceps and torn away, and prostatic adenoid tumors may likewise be enucleated. Key noticed this in 1837; Fergusson brought the subject forward at the Pathological Society in 1848; Cadge exhibited two specimens in 1862; and in 1878 I reported two others. I removed one in the fork of my forceps, an inch in diameter, on January 19, 1875, when operating for stone upon a man æt. 67, with a mulberry calculus one inch and a half in diameter, and the man made an excellent recovery. The second was from a patient æt. 70 who was operated upon in February, 1876, the prostatic tumor being enucleated during the extraction of a large stone with the forceps, and the recovery was complete.

When the stone is *soft, friable*, and comes away piecemeal, it is wise to wash the bladder well out with a stream of tepid water; and at times, when the stone is apparently

held by the bladder in such a position as forbids its being caught by the forceps, a stream of water through the bladder may dislodge it and allow of its removal.

Very large stones should be crushed through the perineal wound before their removal, and a short strong lithotrite is the best instrument for that purpose.

In moderately large stones, when the wound in the neck of the bladder is not large enough, Liston's advice should be followed and an incision made on the opposite side of the neck of the bladder by passing a blunt-pointed bistoury into the wound, guided by the finger, and turning its edge toward the *right* tuber ischii. Martineau says that he likewise often enlarged the inner wound two or three times to facilitate the escape of the stone.

When a *second stone* forms in the bladder and another operation is demanded, there is no reason why it should not be performed in the same position and manner as the first, and with equal success. At intervals of three and fifteen months I have had to cut a patient æt. 60 three times for stone, removing on the first occasion seven calculi, on the second two, and on the third two, with good results. The stones averaged on each occasion more than an inch in diameter. The patient did as well after the second and third operations as after the first, and is now quite well. The Norwich statistics, as compiled by Mr. C. Williams, show that a third operation may be performed with like success (*Lancet*, May 18, 1878).

Other Operations.

The **median operation** is the old Italian or Marian method, based upon the precept "A small incision, much dilatation," and has been revived by Allarton. It is performed as follows: The operator first introduces an ordinary grooved staff into the bladder and gives it to an assistant. He then passes his left forefinger into the rectum, with the palmar surface upward as far as the *apex of the prostate*, and holds it there as a guide to the next step of the operation. He then takes a long straight bistoury, and, with its edge upward, introduces it about half an inch in front of the anus in the median line, down to the membranous portion of the urethra or apex of the prostate, into the groove of the staff, and presses it toward the bladder for about half an inch. He then cuts upward, dividing the membranous portion of the urethra freely and the soft parts of the perinæum, making an external wound about an inch and a half long. Through this wound he next introduces his finger into the bladder with a rotatory movement, the prostatic portion of the urethra and the neck of the bladder being dilated; the forceps are then inserted into the bladder and the stone removed.

Where the stone is large Allarton employs Weiss's three-bladed female dilator or Arnott's hydraulic dilator.

This operation as described is precisely the one now generally performed for the digital exploration of the bladder and the removal of growths from the bladder. It is found to give abundance of room for these purposes, and may therefore be said to be of value for the removal of foreign bodies or stones of moderate size from the bladder. I have employed it in several cases of stone during the last three years with success, and in one case removed five calculi over half an inch in diameter with facility. I am indeed disposed to think that this operation may prove to be better than the lateral in old subjects, for it is certainly attended with less hemorrhage. In children the dilating process is dangerous and apt to be attended by a tearing away of the neck of the bladder from its perineal attachment. The experience of Norwich surgeons, however, in no way tends to give it any support, the mortality of the median being nearly twice as great as that after the lateral operation.

Dolbeau's operation must be mentioned as a modification of the median. A full description of it can be found in his work *La Lithotritie Périnéale* (1872). In its first step, where the membranous portion of the urethra is opened, it differs in no important respect from Allarton's, but in the second the neck of the bladder and parts external to it are dilated, while in the third, unless the stone be very small, it is broken before removal.

The dilating process—an essential part of the operation—is effected by means of a very ingenious six-bladed dilator, the blades of which are so arranged as to separate without diverging by means of two balls which move upon a central stem.

The external parts down to the urethra are dilated first, then the membranous portion of the urethra, and lastly the neck of the bladder, the passage into the bladder by these successive dilatations being of uniform calibre and with smooth walls. The stone is broken, not crushed, by the "cassepièrre," an instrument that opens in the bladder without divergence of its limbs. The fragments should then be removed with care and the bladder washed out.

Dolbeau claims for this operation great advantages which are not yet proved. The instruments, however, are very ingenious.

Dupuytren's bilateral section of the prostate for the removal of large stones, with the semilunar transverse perineal incision in front of the anus, meets with few supporters at the present day. He made his first incision with a scalpel down to the membranous portion of the urethra, and afterward introduced into the groove of the staff a double-bladed curved lithotome, which was pushed, closed, down to the stone into the bladder along the staff. The blades were then opened transversely and the instrument withdrawn. By these means the neck of the bladder and the prostate were freely incised, the prostatic section having an oblique direction downward.

Civiale's Operation.—Civiale in 1836 suggested his medio-bilateral operation, "being dissatisfied with the bilateral, and shunning the lateral method on account of the anatomical objections." Having introduced a staff with a median groove, he made an incision in the median line an inch and a half long in front of the anus down to the membranous portion of the urethra. He made also a free opening into the urethra, and then introduced an instrument similar to Dupuytren's lithotome, but straight, along the groove of the staff into the bladder, opening the blades when the bladder had been entered, and dividing the neck of the bladder on its withdrawal. The finger was then introduced, the staff removed, and the forceps inserted, the stone being removed as in other operations. It differs little from Dupuytren's except in the form of perineal incision. Sir H. Thompson, who first described this operation in England, and Erichsen have both successfully removed calculi by this operation.

Buchanan's Operation.—Dr. Andrew Buchanan's operation with the rectangular staff, bent three inches from the point and deeply grooved laterally with a posterior opening, is essentially a central operation. He suggested it in 1847. The staff is introduced into the bladder and guided by the finger in the rectum; the angle of the staff is made to correspond to the apex of the prostate. The operator, still retaining his finger in the rectum, inserts a long straight bistoury in front of the anus, with the blade horizontal and the edge turning to the left down to the groove and angle of the staff, and pushing it toward the bladder, to stop at the end of the staff. He then withdraws the knife, and as he does so makes a curved incision through the soft parts around the left side of the rectum toward the tuber ischii, the wound being about an inch and a half long. Dr. Buchanan describes his operation as being half that of Dupuytren's. When the stone is large, the right side of the prostate is cut, thus approaching it more nearly as a whole.

The recto-vesical operation was at one time a very favorite one. The late Mr. Lloyd of St. Bartholomew's was about the last English surgeon who freely practised it, whereas now it has been almost lost sight of. The operation consists in the introduction of the knife into the rectum, with the blade flat upon the palmar surface of the right index finger, the turning of the edge of the knife upward, and the perforation of the bowel and urethra at the apex of the prostate down to the groove of the staff, the sphincter and soft parts being freely divided upward in the median line of the perinæum for about one inch on the withdrawal of the knife. The left forefinger is next inserted into the wound down to the groove of the staff, and the bistoury again introduced with its edge downward and pushed into the bladder along the groove, the neck of the bladder and prostate being freely divided when the stone is large. The finger is then passed into the bladder along the staff, the staff removed and forceps passed, the calculus being extracted in the usual way. As an ordinary operation this is greatly inferior to the lateral. König's statistics, as quoted by Poland, show it to be very unsuccessful. When the stone is very large, it may, however, be entertained.

Supra-Pubic Operation.—The high operation, or supra-pubic, is one of the oldest, and was practised by Cheselden and Civiale. It was at one time supposed to be the most direct and least dangerous operation, the only dangerous part involved in it being the peritoneum, which can readily be avoided. For large stones it may be entertained.

The operation consists of three stages:

The *first* consists in exposing the anterior wall of the bladder by a vertical incision made in the median line above the pubes through the parietes, with the patient on his back, his pelvis raised, and the bladder moderately distended with a one-per-cent. solution of carbolic acid or thymol of the temperature of the body, and well raised out of the pelvis by the rubber rectal dilator (Fig. 363).

The *second* step is that of opening the bladder, and care should be observed that this

opening is made in the median line and *close to the symphysis*. This is best done by transfixing the bladder where it is exposed and opening it from below upward, care being also observed that the wound in the abdominal parietes is carefully kept open with retractors.

The *third* step is the removal of the stone by means of forceps.

After the operation the wound in the bladder should be brought together carefully with sutures and the external wound closed above, a space being left below for drainage, and the case left to nature. The urine should subsequently be drawn off at short intervals.

The statistics of the operation are not quite satisfactory. Gross gives 1 death in 4 cases; Civiale, 1 in 2; Humphry of Cambridge and Dulles, 1 in 3. The latter author speaks highly of it (*American Journal of Med. Science*, July, 1875; April, 1878). He believes the operation to be deserving of more attention and should receive a fairer trial than it has yet had.

All these varieties of operations have been detailed, as exceptional cases of stone may be met with in which one or the other may be better than the lateral; but as a general operation lateral and median lithotomy are the best, and, of the modes of performing the lateral operation, Key's is the simplest and most successful.

Causes of Death after Lithotomy.

When patients die unrelieved with calculus, they generally do so from kidney disease; and in the majority of fatal cases of lithotomy the same cause produces a like result. When kidney disease is *not* present, any of the operations described for the removal of the stone, when performed with average skill, is likely to be successful. When kidney disease exists, any operation is likely to prove unsuccessful.

These facts are fully illustrated in a paper I read in 1862 (Roy. Med. and Chir. Society) on the causes of death after lithotomy.

Prognosis.—The longer a stone remains in the bladder, the greater are the probabilities of renal disease; and, consequently, the larger the stone, the greater the risk.

The duration of the symptoms and the size of the stone are, consequently, valuable aids in forming a prognosis.

When death takes place from so-called shock, it is probably connected with organic renal disease.

In a small proportion of cases death takes place from hemorrhage, such a result, however, when uncomplicated, being very exceptional. It does not probably occur once in a hundred cases.

Pelvic cellulitis and peritonitis have usually been regarded as common causes of death. Pelvic cellulitis is very insidious, and often only positively made known when some peritoneal complications make their appearance. Its cause has generally been assigned to a too extensive incision of the neck of the bladder, but the careful investigation of a large number of fatal cases suggests the probability that, although a fatal complication, it is one which for the most part arises without urinary infiltration and as a result of continuity with structures that have become inflamed from injury sustained during the operation or from the prolonged presence of the stone. It is also commonly associated with renal disease, and it is now well known that under such circumstances the inflammation of serous membranes is very common. It is, consequently, an open question as to how far the renal disease or the operation is the cause of the pelvic cellulitis and peritonitis.

Death from acute cystitis may occur, as it may from the hemorrhagic diathesis, pyæmia, chloroform, or any accident.

Uræmia as a cause of death is classed with renal disease.

In children incontinence of urine is apt to follow the operation, particularly when the horizontal position has not been rigidly enforced during the healing process. It is, however, a rare effect.

Wasting of a testis may likewise take place from some disease or wound of the vas deferens. I have, however, known this to occur but once, but cases of it have been recorded by Teevan and others.

STONE IN THE FEMALE BLADDER.

Calculi are doubtless formed as frequently in the kidney of the female as in that of the male, and pass downward into the bladder, although, from the absence of the prostate, as well as owing to the shortness and dilatability of the female urethra, they rarely require surgical treatment.

The records of surgery contain many instances in which large calculi have been passed by natural efforts from the female bladder without any very injurious effect resulting, and Mr. Clogg of Looe, Cornwall, has recorded a case in which a stone nearly four inches round was thus passed (*Brit. Med. Journ.*, May 2, 1074). But the experience of every surgeon will supply him with instances in which calculi of moderate dimensions have been readily passed, and I have a specimen of mulberry stone nearly an inch in diameter which a young woman thus got rid of.

In neglected cases of vesical calculi in women the stone may, however, excite ulceration of the bladder or be discharged *per vaginam*.

Symptoms.—The symptoms of stone in the bladder of the female are very similar to those in the male, such as irritability of bladder, pain during and after the act of micturition, intermittent flow of urine, and hæmaturia, a bearing-down pain and incontinence of urine being common accompaniments. In the female sex uterine and vesical symptoms are so closely associated that surgeons cannot be too much aware of the fact, since cases of stone in the bladder are frequently passed over as examples of uterine disease, when a vaginal examination would reveal the true state of affairs; a calculus can often be felt by the finger through the vesico-vaginal septum, but where doubt exists the sound will settle the point.

Treatment.—The treatment of stone in women is far less complicated than in men, on account of the anatomical formation of the parts; and the majority of calculi can be readily removed either by urethral dilatation and extraction or by lithotrity.

The method by *urethral dilatation* is based on the natural one of expulsion, and is applicable in all cases of small calculi. In children a stone three-quarters of an inch in diameter, and in adults of one inch in diameter, with the patient under the influence of an anæsthetic, may be fearlessly removed from the bladder by rapid urethral dilatation and extraction. Indeed, I have removed calculi two inches in diameter by this means without any injurious after-effect; but it is probably wise not to make the attempt, the surgeon possessing in lithotrity an efficient aid or substitute.

Slow dilatation of the urethra is almost certain to be followed by incontinence, while after rapid proceedings it is rare to meet with this result.

The operation may be performed as follows: With the patient on her back, under the influence of an anæsthetic, the urethra should be dilated by my urethral dilator (Fig. 438) sufficiently far to allow of the introduction of the left index-finger, or by Weiss's three-pronged dilator, which should be introduced and rapidly expanded. The forceps should then be introduced, when the stone, having been seized, can be rapidly removed. I have on several occasions employed the lithotrite for this purpose, with the view of crushing the stone should any difficulties be experienced in its extraction, and therefore recommend the practice. On four occasions I have not dilated the urethra at all, but passed the lithotrite or forceps and extracted at once, and consider this plan is as good as any other; for every surgeon must be struck with the facility with which a finger or any moderate instrument can be introduced into the female bladder when the subject is under the influence of an anæsthetic.

If any difficulty is felt in the extraction of the stone or it prove larger than can be safely removed as a whole, it may be broken up and removed piecemeal. By these means I took away at one operation without any difficulty or bad result, from a child only four years old, a calculus an inch and a half in diameter, and in the year 1869 I successfully removed with facility three calculi from three patients by these means. In female subjects there can be no such hesitation as to the wisdom of removing fragments after the crushing operation as there is in males.

Fig. 396.

Calculus removed from the Female Bladder through the Vagina. (Half natural size.)

When the stone is too large for removal by rapid dilatation, or the bladder too contracted, inflamed, and ulcerated to allow of lithotrity, the stone should be removed *per vaginam*, the surgeon in this operation again imitating a method sometimes resorted to by nature. To do this a clean incision of sufficient length to admit the removal of the calculus has to be made into the bladder through the vaginal septum, guided by a director introduced through the urethra. The wound should subsequently be closed by means of stitches, as in vesico-vaginal fistula.

In this way I have removed with good success a stone two inches long that formed a complete cast of the contracted bladder (Fig. 396). Dr. Aveling and M. Vidal strongly recom-

mend this operation, while the late Marion Sims thought so well of it as to assert "that it is the only justifiable operation for stone in the female bladder;" and if by the word "operation" he means a cutting one, he is certainly right, for where the urethra has been divided to allow of the removal of stone incontinence is a common consequence.

Urethral lithotomy is here mentioned only to be condemned, as any incision into the neck of the female bladder is liable, as has just been said, to be followed by incontinence of urine, half the cases, as a rule, being so affected.

By way of summary, therefore, it may be concluded that a stone of moderate size may readily be removed from the female bladder by immediate extraction, and one of larger dimensions by lithotrity and extraction, the patient being *fully* under the influence of an anæsthetic; that where, from the size of the stone, immediate extraction is not advisable, or from the condition of the bladder lithotrity cannot be performed, vaginal lithotomy is the best operation, while all slow dilatation of the urethra is to be avoided and all urethral lithotomy condemned, on account of the frequency of incontinence of urine as the result of such treatment.

(For further information and statistics, *vide* Dr. Aveling, *Obst. Trans.*, 1864; and paper by author, *Med.-Chir. Trans.*, 1864.)

Foreign Bodies in the Bladder.

These are occasionally met with in both the male and the female subject. Broken catheters and bougies are probably the most common, but a tobacco-pipe, pins, French chalk, slate-pencil, straw, a silver toothpick, penholder, etc., are in the Guy's Museum recorded as foreign bodies that have been removed from the male bladder, and a bone bodkin-case, a cedar-pencil, and a stiletto from the female.

Foreign bodies may, however, obtain access to the bladder through wounds, gunshot or otherwise, or through abscesses connected with bone. Brodie has related a case in which he removed from a young lady a calculus which contained "a small portion of bone and two imperfectly formed human teeth," doubtless the remains of a blighted ovum or contents of some dermoid cyst; and a second, in which a stone from the female bladder had a hazel-nut as a nucleus.

When a foreign body remains long in the bladder, it acts as an irritant and usually becomes rapidly covered with phosphates (Fig. 383). In a specimen at the College of Surgeons a foreign body is the nucleus of a uric acid calculus.

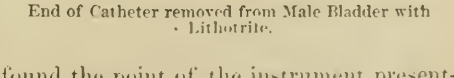
As soon as a foreign body is known to exist it ought to be removed. Where this can be effected through the urethra, so much the better; and as long as the substance is in the passage and not impacted, this may be done; but when this cannot be effected and the urethra is the seat of the offending body, a clean incision should be made and the foreign body removed, as incised wounds into the urethra usually heal well, and it is better to make them than to lacerate the urethra by forcible internal manipulation.

I had a case some years ago in which a long hairpin had been impacted in the penis and perinæum with its points forward, one end being felt at the base of the penis imbedded in the tissues beneath the skin. Under chloroform, I pressed the point through the skin and gradually withdrew the pin, which came out nearly straight. A rapid recovery followed, without a bad symptom.

When the foreign body is in the bladder and cannot be crushed by the lithotrite or drawn out by the scoop, cystotomy must be performed, and in adults, when the foreign body is not large, the median operation should be chosen.

The portion of catheter illustrated below (Fig. 397) I removed from the bladder of Mr. B——, æt. 61, on August 23, 1875, by means of a small lithotrite, thirteen days after it had been broken off in the bladder. I was fortunate enough to catch it at its bulbous end and to withdraw it without much difficulty, a rapid recovery following.

Fig. 397.



End of Catheter removed from Male Bladder with Lithotrite.

In *women* under the influence of an anæsthetic the body may usually be readily extracted by means of dressing or other forceps. In the case in which a lady's stiletto (Fig. 398) was in the bladder of a young woman, I found the point of the instrument presenting forward and upward and fixed in the symphysis. With my left finger in the urethra, I pressed it back, and after some little manipulation with the right index finger through the rectum—for the patient was a virgin—I so placed the stiletto as to fix the point

against the pulp of my left index finger, and with a pair of forceps introduced upon my finger extracted it. The patient recovered without any inconvenience.

Most cases may, indeed, be treated with a pair of forceps in the bladder and a finger

FIG. 398.

Stiletto removed from Female Bladder.

in the vagina or rectum to manipulate and place the foreign body in a good position for removal, the surgeon seizing the foreign body by one end. For the removal of such a thing as a hairpin a blunt hook may possibly be serviceable.

CHAPTER XXIII.

SURGERY OF THE URETHRA.

A DIMINUTION in the calibre of the urethra the result of organic changes within its walls gives rise to *stricture;* any encroachment on the passage from without or within causes *obstruction.*

Obstruction occurs when the urethra is narrowed from inflammatory engorgement of its mucous and submucous tissue (the inflammatory stricture of some authors) or from spasm of the urethral muscles (spasmodic stricture); when an abscess or tumor outside or any prostatic enlargement encroaches on the urethra or when any fracture of the pelvis presses upon it; and lastly, when a calculus or foreign body is impacted in the passage or a urethral polypus blocks it up.

Organic stricture is caused by the contraction of inflammatory deposit situated upon, within, or beneath the mucous membrane of the canal, or from the contraction of the cicatrix of a ruptured or injured urethra. The first form may be described as *simple organic stricture;* the second, as *traumatic or cicatricial stricture.* The former is the more common, my notes showing 603 examples of the former to 43 of the latter in consecutive cases, or in the proportion of 14 to 1.

In the majority of cases the contraction of an organic stricture is of a chronic nature, and in some may be readily traced to a more or less distinct chronic inflammation of the passage; but years will frequently pass before the obstruction to the flow of urine becomes of sufficient importance to arrest attention, and a sudden attack of retention of urine, induced by some act of irregularity or exposure to cold, will probably be the first symptom to draw the patient's attention to his condition.

The stricture may consist simply of a perforated membranous diaphragm stretched across the canal; of a narrow band of inflammatory product surrounding the passage, to which the terms "whip-cord," "ring," or "annular" stricture are attached; and in rarer cases to bands of lymph stretching across the passage and forming what are known as "bridle" strictures. It may be general or partial, and when the latter may have been caused by some adhesion either of the natural rugæ of the urethra or of some folds of its mucous lining. When the stricture is more extensive, there is hardly a limit to the extent of inflammatory deposit which may exist, from the narrow band already alluded to as forming the "annular" stricture, passing onward to the broader band which answers to Sir A. Cooper's term of "ribbon" stricture, to the still severer cases in which the urethra is found more or less contracted throughout its entire course. Between these extremes numberless varieties and degrees of mischief may be observed, the urethra presenting one single contraction or several independent ones. John Hunter mentioned a case in which six strictures coexisted.

Lastly, the urethra may unquestionably become "impermeable," the pathological specimens in Guy's Museum being sufficient to demonstrate the fact. Such a condition, however, cannot exist uncomplicated with other symptoms, since it is obvious that the

urine must have some channel for escape. In these cases, therefore, urinary fistula will always be found. An *obliteration* of the urethra the result of injury from cicatricial stricture is also met with.

Locality of Stricture.—For the only definite facts relating to this subject I must refer—and I do so with pleasure—to the labors of Sir H. Thompson; for, although other writers have given their "impressions" upon the subject and published isolated cases, it is to him that the profession is indebted for the analysis of two hundred and seventy preparations contained in the various museums, by which inquiry alone this question could have been satisfactorily determined. He has most satisfactorily proved what is now generally received as true—that in by far the majority of cases of stricture the juncture of the spongy and membranous portions of the urethra is its most frequent seat (Fig. 399), and that the inch situated in front of this spot is the next position in point of frequency, while exceptional cases may be found in the prostatic end of the membranous portion, at the external orifice, or at the terminal two inches of the urethra; but no specimen existed in which a stricture has been observed in the prostatic portion.

FIG. 399.

Stricture of the Urethra, with Dilatation of Urethra behind Stricture and Hypertrophy of Bladder

Looking over my own cases with a view to inquiring into the *causes of stricture*, I find, omitting congenital narrowing of the urethra, that chronic gonorrhœal inflammation had existed in 273 out of the 646 instances, and that in 78 of these injections had been employed in its cure; that direct injury was the assigned cause of 43, while in 330 no definite cause could be obtained. With these facts it seems, therefore, right to conclude "that, although gonorrhœa often precedes a stricture, at least half the cases are found in subjects who have not suffered from such a disease, and that when gonorrhœa might be assigned as a cause the use of injections for its cure does not appear to have had any positively injurious influence in producing a stricture." I may add that these results can be strictly relied on, as when noting the cases considerable care was taken to search out this fact. It may, therefore, unquestionably be asserted that injections have not the injurious influence in exciting stricture which some authors have ascribed to them.

Among the 330 cases in which no positive cause could be assigned were 3 in which "gout" existed, and several in which the contraction of chancres might fairly be ascribed as the cause of the obstruction.

I have been unable to discover that the so-called phosphatic diathesis has any influence in exciting the formation of an organic stricture or any other urethral disease, although this is a point upon which Sir. B. Brodie has largely dwelt; but there can be no doubt that any morbid condition of the urine has considerable power in exciting a spasmodic contraction of the muscular walls of the urethra, more particularly when an organic stricture exists, and of inducing retention of the urine.

SYMPTOMS.—In a large proportion of the cases of simple organic stricture an attack of retention of urine is the first thing which attracts the attention of the patient, which may have followed some indiscretion in diet, excess of drinking, or exposure to cold. It is then, perhaps for the first time, that the patient can bring to his recollection the fact that other less marked, but not less certain, symptoms had previously existed for some time. It may be that a *chronic gleet* had been present for many months or that some urethral pain or difficulty had attended the act of micturition, that the stream of urine had been somewhat narrowed, divided, twisted, or of a screw shape, or that micturition had been more frequent or prolonged; yet these symptoms by themselves had failed to make sufficient impression upon the mind of the sufferer as to lead him to suspect the existence of a stricture.

It must not be thought, however, that the retention is usually caused by the gradual contraction of the stricture, though in exceptional cases such a condition may exist; yet it is tolerably certain that in the majority the retention is due to some spasmodic action of the urethral muscles at the seat of stricture, for very slight causes appear capable of exciting spasmodic action of the canal in a diseased urethra, and consequently of giving rise to retention, spasmodic and organic stricture being generally combined. Indeed, out of 483 cases of stricture consecutively admitted into Guy's, 129, or more than *a fourth*, were suffering from retention. When the stricture is not discovered under these circum-

stances, it will, if not detected early, soon give rise to other and more characteristic symptoms. The stream of urine will gradually contract, so that it will at last cease to exist, the urine passing only in drops. The bladder will become so irritable that the patient will have to rise frequently in the night to micturate, and the effort will be attended with pain; a small quantity of urine, moreover, will probably also be passed; symptoms affecting the rectum will soon appear, and the straining during the act of micturition will be associated with tenesmus, these symptoms at times being so severe as to necessitate, whenever natural relief is sought, the use of the stool instead of the chamber-vessel. Prolapsus recti or piles also frequently complicate the case, while incontinence of urine may follow.

Under these circumstances it is clear that the bladder is never emptied, although some small quantity of urine may be passed at each act of micturition. The retained urine, undergoing partial decomposition, acts as an irritant and becomes cloudy and ammoniacal, depositing more or less mucus and phosphates. The urine, collecting, gives rise to distension of the bladder, which, pressing on the rectum, excites tenesmus and prolapsus, and, interfering with the return of the venous blood, to piles. As the distension increases the bladder loses its power of contraction, and consequently expands till it overflows, the *overflow* of urine giving rise to *incontinence*, which is a direct result of chronic retention. A physical examination of the abdomen of a patient under these circumstances will reveal the distended viscus as a central globular swelling giving a dull sound on percussion.

During these changes others no less important are going on at the seat of stricture: the urethra behind the stricture dilates, this dilatation being mechanical and the direct result of the ineffectual efforts of the bladder to overcome the obstruction (Fig. 399). As the pressure continues inflammation of the urethra and parts around appears; the tissues as they expand become indurated, and after a time ulcerate. A few drops of urine, as a result, then percolate into the cellular tissue behind the stricture, and, setting up suppuration, form a urinary abscess, which to the finger will appear as a deep-seated perineal swelling. When the abscess is slow in its formation it will be indolent and painless, but if rapid very painful; when opened or left to natural processes, it will, almost to a certainty, be followed by a *perineal urinary fistula*.

If, however, the abscess and the urethral stricture be left unrelieved and the bladder with the abdominal muscles still continues to act ineffectually to overcome the urethral obstruction, the urine, by being forced into the dilated urethra behind the stricture and into the perineal abscess communicating with it, will sooner or later cause rupture of the abscess into the cellular tissue of the parts around, and as a result give rise to extravasation of urine.

When the parts thus gave way during the efforts of the patient to overcome the stricture, or some uncontrollable spasmodic action of the bladder and abdominal muscles, a sudden relief from the previous agony and a sensation that something has yielded may for a time lull the apprehensions of the patient and mislead him into the idea that all is well; but the swelling of the perinæum, scrotum, penis, and supra-pubic region, which must soon follow, with the absence of any flow of urine through the natural channel, will reveal to the professional eye the true nature of the accident, and prove that the urethra has given way behind the stricture and that *extravasation* of urine has taken place.

Instruments for the Detection of a Stricture.—For the detection of a stricture, as well as for its dilatation, *metallic* catheters, *elastic* catheters, or *filiform* bougies may be employed.

The metallic catheter I prefer is that shown in Figs. 384, 385. The curve being short and the end bulbous and a size larger than the shank, this form of catheter is very perfect for mere examination purposes. The elastic instruments are upon the French model and are made of the same material throughout, a groove in the top answering as a substitute for the ivory head, which is never known to keep its place; and when a catheter has to be fastened into the bladder, the benefit of this arrangement is at once proved. These catheters are made very small (Fig. 400), even to the half size. For dilating a stricture they should always be preferred.

The filiform bougies are made of the same material as the elastic catheter or of catgut or whalebone. I prefer the first and last, as they are made very fine and smooth, with or without olive tips; some are of the same thickness throughout, whilst others have finer points than shafts. They can often be insinuated through a narrow stricture when a catheter cannot be introduced, and are consequently of great value for dilating purposes.

As guides into the bladder they are also of equal use, and particularly for internal or

external urethrotomy. When these small bougies are used, the urethra should be previously filled with oil.

Unfortunately, the sizes of the French and English catheters are not alike, the former being much more gradual in their increase. I append a table of the two scales:

No.	1	English	=	No.	7	French.	No.	10	English	=	No. 19 French.
"	2	"		"	8	"	"	11	"		" 20 "
"	3	"	=	"	9	"	"	12	"	=	" 22 "
"	4	"	=	"	11	"	"	13	"	=	" 23 "
"	5	"	=	"	12	"	"	14	"	=	" 25 "
"	6	"	=	"	15	"	"	15	"	=	" 26 "
"	7	"	=	"	16	"	"	16	"	=	" 27 "
"	8	"	=	"	17	"	"	17	"	=	" 28 "
"	9	"	=	"	18	"	"	18	"	=	" 30 "

General Symptoms.—During the development of a stricture, and more particularly when the stricture has become a real cause of obstruction, a patient's general condition is rarely good, and what are generally known as dyspeptic symptoms commonly exist; as a consequence, from the digestive organs failing to do their duty as in health,

FIG. 400.

the patient often loses flesh and looks careworn and ill. As the disease progresses a constant feeling of chilliness is very common, and rigors, followed by fever, are not unusual; these symptoms are at times intermittent, and are often regarded as being due to "ague." When a perineal abscess is forming, they are commonly present.

When the rigors are uncomplicated with abscess and are still frequent, there is good reason to believe that they indicate some renal complication; for it cannot be too strongly impressed upon the surgeon's mind that no stricture can long exist without producing secondarily important changes in the bladder and kidneys.

Results of Stricture.—When a stricture is neglected, renal disease is certain to follow; and when death takes place as a consequence of stricture, it will be from kidney disease if it has not been suddenly brought about by one of the complications of stricture, such as retention or extravasation of urine. Thus, out of 100 deaths from stricture analyzed by Dr. Goodhart, the kidneys were suppurating in 41, wasted or inflamed in 18, diseased in a less degree or cystic in 7, and healthy in 34, or about one-third.

Organic strictures are not, however, all of the same character.

The simple stricture is the most usual, and beyond the mechanical effects of its existence has no special feature. **The irritable stricture** is comparatively rare, and is characterized by excessive sensibility on being touched by a catheter, with a disposition to bleed. It is also prone to be associated with chilliness, and even rigors. **The contractile stricture** may belong to either of the former two groups, its peculiarity consisting in its tendency to *recontract after its dilatation*. The **cicatricial or traumatic stricture** has characters of its own, and, of these, its obstinacy is the most marked.

It is important to bear these divisions of organic stricture constantly in mind, for the successful treatment of a case will often turn upon their recognition.

Examination for Stricture.—Before a surgeon can say with certainty that a stricture exists a urethral examination is often a necessity, and this is an operation in which difficulties are met with by the inexperienced; indeed, without some skill and confidence the attempt to pass a full-sized catheter down even a healthy urethra constantly fails.

To pass a catheter it is usually wise to place the patient in the recumbent position, with the shoulders slightly raised and the knees separated; he should, too, be lying quite straight, with the abdomen exposed to the navel, as the linea alba is the best guide as to the line of the urethra. A large metallic instrument (No. 7 or 8 being the best) should be selected for the examination, made moderately warm by being dipped in warm water or rubbed by the hand, and thoroughly well oiled. The operator should stand on the *left* side of the patient, and, raising the penis with his left hand, should introduce the end of the catheter into its urethral orifice, keeping its point during the introduction of the first three or four inches well to the *lower* surface of the urethra, in order to avoid the lacunæ that exist in the roof of the passage. The handle of the instrument at this step of the operation may be directed over the left thigh of the patient, or, what is preferable, maintained over the median line of the body in the direction of the umbilicus. With the left

hand he may then gently draw the penis up the instrument, while he allows the catheter by its own weight to slip down the passage, simply directing it with a light hand. When its end has reached the bulbous portion of the urethra, the handle of the catheter must then be gently depressed in the central line of the body; and if no obstruction exists, the bladder will be entered, the point of the instrument during this movement being kept well along the *upper* surface of the urethra. In a healthy urethra, indeed, the surgeon has little more than to *guide* a metallic instrument into the bladder, the weight of the catheter being alone nearly sufficient to allow it to pass down the passage. Half the errors committed in catheterism arise from a non-appreciation of this fact, the desire to *pass* the catheter originating efforts that interfere with the entry of the instrument into the bladder under proper guidance.

When a stricture exists, the catheter will be arrested in its course; and under these circumstances it should be withdrawn an inch or so and passed on again, with the handle slightly altered in direction. If the resistance is still felt, the instrument should be withdrawn and one of a smaller size employed, and on this failing to glide by the obstruction a yet smaller one should be tried; and so on till the stricture is entered.

The seat of stricture or strictures, as well as the nature of the contraction, will be made out by this process. If much pain attend the examination, either the surgeon has employed too much force or an irritable stricture exists; and if bleeding follows, this latter probability is strengthened, particularly if no violence has been employed. Catheterism, indeed, ought never to be attended with violence; and if gentle measures do not succeed, no other should be attempted.

In passing a catheter some prefer the patient to be in the erect position, but I cannot recommend it; there is more chance of inflicting injury in this position by the patient moving, and the surgeon has not so complete a control over his instrument or patient as when he is recumbent. When there is a stricture, the erect position is certainly wrong. The mode known as the *tour de maître* has to be named only to be condemned, though in the hands of a skilled surgeon it may be used with impunity. The plan consists in introducing the catheter—the patient standing—with the handle presenting downward and the convexity of its curve upward, passing it along the urethra down to the bulb, and then onward into the bladder by describing a half circle toward the umbilicus, the handle of the instrument, when it has reached the median line of the body above, being gradually depressed, and the end of the instrument in this turn made to enter the bladder.

Treatment.—The treatment of stricture must be based on the pathology of the disease, and mild means should always be preferred to forcible or cutting measures.

The pathology of stricture is simple and consists either in the deposition of inflammatory products in the mucous and submucous tissue, with their subsequent contraction, or in the contraction of a cicatrix the result of an injury.

The principle of treatment is also simple, for it is *primarily* to dilate the contracted canal, and *secondarily* to obtain the absorption or breaking up of the effused inflammatory products. The more simple the means by which these ends can be secured, the better.

Where the first end has been obtained without the second, temporary benefit may have been effected, but no more. Where both ends can be gained by simple means, the treatment must be pronounced good. In ordinary cases of organic stricture there is little doubt that these ends are to be secured by *dilatation* of the stricture, and that by such local treatment alone the majority of cases of organic stricture may be successfully overcome.

Now, this treatment by dilatation may be *continuous* or *intermittent*. The former method is to be preferred and should be carried out; it is the most rapid and effectual the surgeon has at his disposal, although it necessitates about a fortnight's rest.

The Continuous Method.—The size of the stricture having been gauged, an elastic conical catheter with a bulbous end is to be taken and well oiled, and as large a one as can be passed through the stricture introduced. Should the English catheter be preferred, it ought to be made soft and flexible by being dipped in warm water or by friction with the finger, and used without the stylet. The penis of the recumbent patient must then be raised by the left hand and drawn forward as well as slightly downward, so as to make the urethra as straight as possible. The catheter should then be introduced and passed gently down the passage. If obstruction be felt, the catheter may be slightly withdrawn and then pressed forward. The largest instrument the stricture will admit without force should be introduced, and, having passed the stricture and entered the bladder, it is to be fastened in (Fig. 401). The end of the catheter up to its eye alone should rest in the bladder.

The orifice of the catheter may be either plugged with a peg of wood or the end

capped by a piece of india-rubber tubing, the free end of which should be dropped into a urinal or tied in a knot to prevent escape of urine.

After twenty-four hours, if the catheter moves freely in the stricture, it may be removed and a larger size introduced, the surgeon being careful not to be tempted to introduce one that fits the stricture too firmly. On the third and following days the same practice may be followed, and in about ten days a complete dilatation of the stricture will probably have been perfected. If the catheter does not move freely in the stricture, it must be left a few hours longer. When the presence of the instrument in the bladder causes irritation which is not remedied by such alkalies as the citrate or tartrate of potash with buchu and hyoscyamus, it is wise to have the catheter removed some few hours before a larger size is introduced, thereby giving the bladder rest. When it is impossible for the patient to maintain rest, a catheter may be passed in the evening, retained all night, and removed in the morning. At other times, where the symptoms are more severe, some slight intermission of the treatment may be advisable, the passage of the catheter alone being practised. After the stricture has been fully dilated the daily passage of an instrument for a few days subsequently is all that is required, the intervals between the introduction of the catheter being gradually lengthened.

FIG. 401

Mode of Fastening Catheter in the Bladder.

The patient need not always be confined to bed during this treatment, but may lie on a sofa or sit quietly in a reclining-chair. When movement, however, causes irritation of the bladder, it must be forbidden.

In severe and neglected strictures this plan is one that ought always to be followed when possible, as it is sound in its principle, safe in its practice, and as expeditious as is consistent with the object aimed at.

Intermittent Dilatation.—The intermittent method of dilatation is required in less severe cases or where rest cannot be obtained, and it can be carried out by the introduction of an instrument on one day, and after the lapse of one or two more its reintroduction, followed immediately by the employment of a larger size, and then the next, and the next size larger still, till complete dilatation of the stricture has been effected. It is the second-best plan the surgeon has at his command, and, although more tedious than the former, is in the end successful; patients so treated, however, require, doubtless, the more frequent introduction of a catheter to maintain the urethra in its dilated condition than others treated by the former plan. For this method of treatment metallic instruments are better than elastic.

When a stricture is so contracted that a catheter cannot be passed even after very careful manipulation, the attempt should be given up and alkalies prescribed. When the urethra is irritable, opium, enforced rest, and the hip bath are of use, and after the lapse of a day or more success may follow another attempt. When the stricture is reached by the catheter, gentle pressure upon it may be employed; indeed, pressure may be kept up for two or three minutes, the parts often yielding under its influence and allowing the instrument to pass. If this end be obtained, let the surgeon be satisfied and leave the catheter in, whether silver or elastic; for should he remove it, he will in all probability fail to pass a second. If the instrument be silver, an elastic one should be substituted when it is removed.

When a catheter is grasped and "held" in the urethra, the operator may be tolerably sure that he has entered the stricture; and when its end is movable, he may be equally sure that he is in a false passage. When the catheter has been held and passed forward into the bladder, all is well; when it slips suddenly into a movable space, the urethra has probably been perforated. Under these circumstances, when a false passage probably exists, it is wise to give up local treatment for a few days, to allow the parts to heal.

A stricture should be dilated up to its fullest extent.

It is important to bear in mind that after the full dilatation of a stricture contraction will again take place after a time if the passage be not kept open, but the introduction of a catheter once in every two, three, four, or more months, according to circumstances, is generally sufficient to prevent such a result taking place.

On Splitting Strictures.—What in modern language is called *the rapid or immediate treatment of stricture* is in reality its rupture or splitting, it being in all probability a rare thing for a stricture to be suddenly, fully, and rapidly dilated without being lacerated. The plan known by this name has certainly a taking title, and in practice has apparent

advantages which, if supported by experience, would establish its claims on the attention of surgeons. In our day it is known as that of Holt, but Holt's instruments are mere modifications of M. Perrève's made in 1847, and the same sort of practice has been adopted by Mr. T. Wakley, Dr. Hutton of Dublin, Maisonneuve, Buchanan, and others.

Holt describes his instrument "as consisting of two grooved blades fixed in a divided handle and containing between them a wire welded to their points, and on this wire a tube (which when introduced between the blades corresponds to the natural calibre of the urethra) is quickly passed, and thus ruptures or splits the obstruction."

The stricture having been split, the dilator should be rotated, to separate further the sides of the rent, and then withdrawn, a catheter corresponding to the number of the tube being substituted, for the purpose of removing the urine. This method, however, no more effects a permanent cure of a stricture than the plan of dilatation, already referred to, since every hospital surgeon has been called upon to treat cases of stricture that have been subjected to this plan and then have relapsed. Indeed, there is reason to believe that after *the rapid method* an early relapse is more common than after others, and that the cicatrices of these split structures contract faster than the original. Bad, and even fatal, effects, moreover, are more common *after* the splitting operation than after gradual dilatation.

The plan of treatment by dilatation I have laid down is safe and rarely followed by a fatal result, but this cannot be said after the splitting of the stricture, although facts are wanted to establish the proportion of fatal to successful cases.

To narrow, ring or annular, subpubic, or penile strictures Holt's method is probably well adapted, but for indurated, ribbon, tunnel, or complicated strictures it is dangerous and unsuitable.

When a stricture is associated with a vesical calculus and it is a matter of necessity to cure the one before lithotomy is employed, the immediate method may be used, but it ought to be understood that a greater amount of danger attends its practice than follows the more ordinary method.

The best instrument for this plan of treatment is that made by Weiss for Mr. B. W. Richardson of Dublin (Fig. 402).

Fig. 402.

Richardson's Dilator.

Other Forms of Treatment.—Yet all strictures cannot be treated by dilatation, for "cases occur occasionally which are so exquisitely sensitive that the passage of a catheter, however skilfully performed, is followed by such severe constitutional and local disturbance as to produce more harm than good, and in which it is clear some other method of cure must be employed; whilst there are others which are relieved by means of the catheter, and even fully dilated, but which have a tendency to recontract immediately upon the omission of the treatment. In the former case the treatment aggravates instead of relieves the symptoms; in the latter it must be continued for life to preserve an open passage. Under such circumstances some other plan of treatment must be adopted;" and I believe now, as when the above words were written, "the most beneficial to be the external division of the stricture from the perinæum, and it is to the late Professor Syme that we are here especially indebted for having so ably recalled our attention to the treatment of such troublesome and painful cases" (*Guy's Reports*, 1858).

The surgeon must not, however, in all cases of irritable stricture come to the conclusion that Syme's operation is required, as it is only in exceptional examples that it is needed, for in some the irritability rapidly disappears under the use of the catheter, and in others rest, alkalies, and opium have a most beneficial influence. If these fail, the cutting operation may be performed.

Recently the laminaria stalks have been employed for dilating stricture, but for perineal strictures they are dangerous and are apt to break. For strictures at the orifice of the urethra from the contraction of cicatrices they are most valuable, but for all other forms they are ill adapted. A laminaria tent swells to at least twice its diameter and may be introduced into the urethra dry and left there, a small shield being fixed to one end, to prevent its slipping into the passage.

Caustics are not at the present day much employed in the treatment of stricture; indeed, few use them. The practice in theory is neither sound nor in its results certain;

indeed, it is probably injurious, since it is impossible to apply such a caustic as the potassa fusa to the seat of stricture alone; and when tissues are destroyed by its influence, they will subsequently cicatrize and contract, and thus add to the mischief. The practice is not one that can in any way be recommended.

Otis's method of treating stricture may be described as a combination of rupture and urethrotomy. He asserts it to be applicable to all cases of stricture situated *anterior* to the bulb, and that it is a radical cure in nine cases out of ten.

The operation is performed by first stretching the stricture to the full; second, slightly cutting it by an instrument with a concealed blade; and third, at once dilating the urethra to a little more than its normal size.

After the operation the urethra is to be maintained at its full size by the daily passage of metal sounds until the incisions have healed.

Urethrotomy

is a comprehensive term, and includes the *internal* division of a stricture from the urethra as well as the *external* through the perinæum.

Internal urethrotomy has now many advocates, and in hard, old strictures it is preferable to their rupture; for strictures also at the orifice of the urethra and within the penis it is a safe and valuable practice. In the hands of some surgeons it has been much practised advantageously, and Mr. Lund of Manchester has lately advocated it. Many instruments have been invented for the purpose, and Stafford's instrument, made in 1827, is well known. Fergusson employed a long grooved director, which he passed through the stricture, and a very narrow-bladed knife, which can be buried in the groove. Many ingenious instruments have been invented, but the best is that which divides the strictures from behind forward on its withdrawal, such as that represented in Fig. 403. It is one that I have had made on Trélat's principle, perforated at its end for a guide bougie. In strictures of the orifice a bistoury may be used.

Fig. 403.

Urethrotome, perforated at End for Guide Bougie.

After the division of the stricture it was a common custom to pass a large catheter into the bladder and leave it in, but M. Gouley has fairly shown that such a practice is not required. In orificial strictures after their division the laminaria tent is the best to use, with a shield.

Maisonneuve employed a filiform gum-elastic bougie as a guide through the stricture, as well as a grooved steel director, which is screwed to the bougie and pushed into the bladder when the stricture has been divided.

Subcutaneous perineal urethrotomy has been practised, but my own experience of it has not been favorable.

External urethrotomy is a valuable operation in selected cases and includes three very different measures—*one*, in which the stricture is divided through the perinæum upon a grooved director passed through the stricture (*external division* or Syme's operation), the *second*, in which the urethra is opened in front of the stricture and a grooved probe passed through it into the bladder previous to its division (Wheelhouse's operation); and the *third*, in which the perinæum is laid open *without* a urethral guide, the stricture being impervious; and to this the term *perineal section* ought to be confined (Cock's operation).

Syme's operation, as already stated, is valuable in the highly irritable as well as contractile stricture, in cases which Syme described as strictures that "continue to present symptoms after being dilated" and that "are indomitable by the ordinary means of treatment." It is, moreover, usually successful.

The operation is by no means one of difficulty. A grooved straight staff as large as can be passed through the stricture is first introduced, the patient having been placed upon his back, as if about to be cut for stone. The surgeon should then with perfect precision introduce his knife into the centre of the perinæum, and at one stroke cut down upon the groove situated at the lower border of the staff, and, using this as his guide, divide the perineal portion of the urethra in which the stricture is situated. There are but two important points to be observed in this the second step of the operation: the first is to be certain that the knife occupies the groove of the staff, and secondly that the whole of the diseased or strictured portion of the urethra is

freely divided. Having succeeded in this the essential part of the operation, and after a grooved probe or director has been introduced into the bladder through the perineal wound, the sound may be removed, when either a full-sized elastic catheter can be readily introduced through the penis into the bladder and fixed in, or Syme's catheter (Fig. 404) may be introduced through the perineal wound for twenty-four hours.

Fig. 404.

Syme's Perineal Catheter.

After-Treatment.—The patient should then be sent to bed and a mild opiate given, such as ten grains of Dover's powder, if much general or local vesical irritability exists. The catheter may be left in for several days if it fail to cause pain, but if the bladder resents its presence it may be removed; indeed, more extensive experience has led me to think that the presence of a catheter is scarcely required for three or four days after the operation, when it should be passed and left in during the healing process.

After the wound has closed the occasional introduction of a catheter is essential, and I cordially agree with Professor Syme in thinking "prudence requires that every patient who has had a stricture divided should learn to introduce bougies, since by doing so at intervals of a week or a fortnight he will be perfectly secure from future trouble." The division of a stricture no more effects a permanent cure than its dilatation or rupture, and occasional dilatation is essential to maintain its patency.

Wheelhouse's Operation.—Mr. C. G. Wheelhouse of Leeds has introduced an operation for impermeable stricture which I believe deserves attention. He states that in his hands and in those of his colleagues it has been most successful.

The instruments required for its performance are as follows:

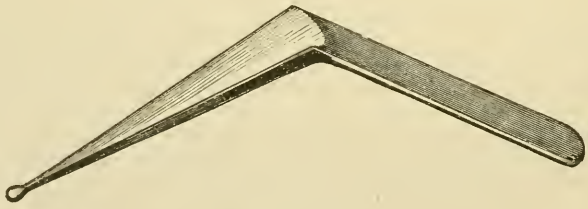
"Lithotomy bandages; a special staff fully grooved through the greater part, but not through the whole, of its extent, the last half inch of the groove being 'stopped' and

Fig. 405.

Grooved Staff, with Button-like End.

terminating in a rounded button-like end (Fig. 405); an ordinary scalpel; two pairs of straight-bladed forceps, nibbed at the points; ordinary artery forceps and ligatures;

Fig. 406.



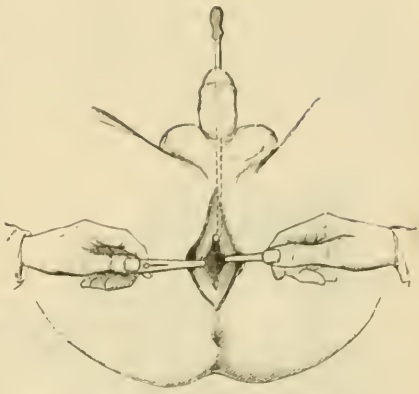
Teale's Probe-Gorget.

sponge; a well-grooved and finely probe-pointed director; Teale's probe-gorget (Fig. 406); a straight probe-pointed bistoury; a short silver catheter (No. 10 or 11 gauge) with elastic tube attached.

"The patient is placed in lithotomy position, with the pelvis a little elevated, so as to permit the light to fall well upon it and into the wound to be made. The staff is to be introduced with the groove looking toward the surface and brought gently into contact with the stricture. It should not be pressed much against the stricture, for fear of tearing the tissues of the urethra and causing it to leave the canal, which would mar the whole after-proceedings, which depend upon the urethra being opened a *quarter of an inch in front of the stricture.* Whilst an assistant holds the

staff in this position an incision is made into the perinæum, extending from opposite the point of reflection of the superficial perineal fascia to the anterior edge of the sphincter ani. The tissues of the perinæum are to be steadily divided until the urethra is reached. This is now to be opened *in the groove* of the staff, *not upon its point*, so as certainly to secure a quarter of an inch of healthy tube immediately in front of the stricture. As soon as the urethra is opened and the groove in the staff fully exposed the edges of the healthy urethra are to be seized on each side by the straight-bladed nibbed forceps and held apart. The staff is then to be gently withdrawn until the button-point appears in the wound. It is then to be turned round, so that the groove may look to the pubes, and the button may be hooked into the upper angle of the opened urethra, which is then held stretched open at three points; thus (Fig. 407), and the operator looks into it immediately in front of the stricture. Whilst thus held open the probe-pointed director is inserted into the urethra, and the operator, if he cannot see the opening of the stricture—which is often possible—generally succeeds in very quickly finding it, and passes the point onward *through* the stricture toward the bladder. The stricture is sometimes hidden amongst a crop of granulations or warty growths, in the midst of which the probe-point easily finds the true passage. This director having been passed on into the bladder (its entrance into which is clearly demonstrated by the freedom of its movements), its groove is turned *downward*, the whole length of the stricture is carefully and deliberately divided on its *under* surface, and the passage is thus cleared. The director is still held in the same position and the straight probe-pointed bistoury is run along the groove, to ensure complete division of all bands or other obstructions. These being thoroughly cleared, the old difficulty of directing the point of a catheter through the divided stricture and onward into the bladder is to be overcome. To effect this the point of the probe-gorget is introduced into the groove in the director, and, guided by it, is passed onward into the bladder, dilating the divided stricture and forming a metallic floor, along which the point of the catheter cannot fail to pass securely into the bladder. The entry of the gorget into the latter viscus is signalized by an immediate gush of urine along it.

Fig. 407.



Wheelhouse's Operation of Opening Urethra.

"The short catheter is now passed from the meatus down into the wound; is made to pass once or twice through the divided urethra, where it can be seen in the wound, to render certain the fact that no obstructing bands have been left undivided; and is then, guided by the probe-dilator, passed easily and certainly along the posterior part of the urethra into the bladder.

"The gorget is now withdrawn, the catheter fastened in the urethra and allowed to remain for three or four days, the elastic tube conveying the urine away to a vessel under or by the side of the bed.

"After three or four days the catheter is removed, and is then passed daily or every second or third day, according to circumstances, until the wound in the perinæum is healed; and after the parts have become consolidated it requires, of course, to be passed still from time to time, to prevent recontraction."

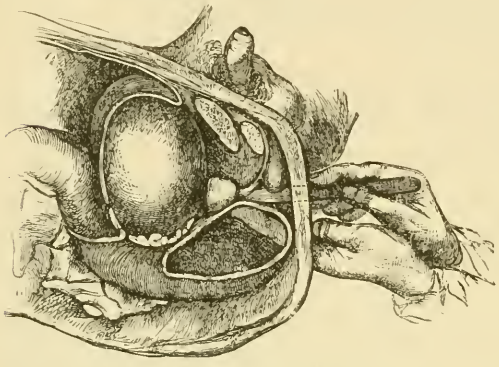
Perineal section, or Cock's operation, is a more difficult and dangerous operation than Syme's, and is called for in far more severe cases—that is, when the urethra is impervious and no guide to the urethra exists beyond that which the surgeon's knowledge of the anatomy of the parts affords. It should also be remembered that, as a rule, the normal anatomy has been nearly destroyed, for impervious strictures requiring urethrotomy are usually chronic, as well as complicated with extravasation, suppuration, or urinary fistulæ.

The operation I shall describe is that one suggested by Mr. Cock and known by his name. "The objects aimed at in the operation can be accomplished, while I doubt if those of any other have ever been fulfilled. However complicated may be the derangement of the perinæum and however extensive the obstruction of the urethra, one portion of the canal behind the stricture is always healthy and often dilated, and is accessible to the knife of the surgeon. I mean that portion of the urethra which emerges from the apex

of the prostate—a part which is never the subject of stricture, and whose exact anatomical position may be brought under the recognition of the finger of the operator. Thus, when we cannot introduce a catheter by the ordinary method, and even when we cannot tap the bladder through the rectum, it still remains to us *to tap the urethra as it emerges from the prostate*, and thus to effect the desired communication."

The operation, which Mr. Cock has described as "tapping the urethra at the apex of the prostate, unassisted by a guide staff," is illustrated in Fig. 408. I have seen Mr. Cock frequently perform it, have done it myself on many occasions, and have no hesitation in strongly recommending it as *the* operation for external urethrotomy without a staff. The only instruments required are a *broad* double-edged knife with a very sharp point, a large silver probe-pointed director with a handle, and a catheter.

FIG. 408.



Mr. Cock's Operation of Tapping the Urethra at the Apex of the Prostrate, or Perineal Section.

"The patient," writes Cock,[1] "is to be placed in the usual position for lithotomy; and it is of the utmost importance that the body and pelvis should be straight, so that the median line may be accurately preserved. The left forefinger of the operator is then introduced into the rectum, the bearings of the prostate are carefully examined and ascertained, and the tip of the finger is lodged on the apex of the gland; the knife is then plunged steadily but boldly into the median line of the perinæum and carried on in a direction toward the tip of the left forefinger, which lies in the rectum (Fig. 408). At the same time, by an upward-and-downward movement, the vertical incision may be carried in the median line to any extent that is considered desirable. The lower extremity of the wound should come to within half an inch of the anus.

"The knife should never be withdrawn in its progress toward the apex of the prostate, but its onward course must be steadily maintained until its point can be felt in close proximity to the tip of the left forefinger. When the operator has fully assured himself as to the relative position of his finger, the apex of the prostate, and the point of his knife, the latter is to be advanced with a motion somewhat obliquely either to the right or the left, and it can hardly fail to pierce the urethra. If in this step of the operation the anterior extremity of the prostate should be somewhat incised, it is a matter of no consequence.

"In this operation it is of the utmost importance that the knife be not removed from the wound and that no deviation be made from its original direction until the object is accomplished. If the knife be prematurely removed, it will probably, when reinserted, make a fresh incision and complicate the desired result. It will be seen that the wound, when complicated, represents a triangle, the base being the external vertical incision through the perinæum, while the apex, and consequently the point of the knife, impinges on the apex of the prostate. This shape of the wound facilitates the next step of the operation.

"The knife is now withdrawn, but the left forefinger is still retained in the rectum. The probe-pointed director is carried through the wound, and, guided by the left forefinger, enters the urethra and is passed into the bladder. The finger is now withdrawn from the rectum, the left hand grasps the director, and along the groove of this instrument the catheter is slid until it enters the bladder.

"The operation is now complete, and it only remains to secure the catheter in its place with four pieces of tape, which are fastened to a girth round the loins.

"A direct communication with the bladder has now been obtained, and the relief to the patient will be immediate; unless the kidneys have become irremediably disorganized, we may confidently anticipate a favorable result; and the restoration of the urinary organs will be more or less complete in proportion as the obstructed portion of the urethra is more or less amenable to the ordinary judicious treatment of stricture.

"The catheter may generally be retained in the bladder for a few days; and if the state of the urine renders ablution necessary, the viscus may be frequently washed out. The catheter may then be removed, cleansed, and reintroduced.

[1] *Guy's Hosp. Rep.*, 1866.

"If the previous destruction has not been very great, and if the case progresses favorably, the swelling of the perinæum and scrotum gradually subsides, the induration disappears, and the urinary sinuses become obliterated. The urethra may then be examined in the ordinary way, to test its permeability, and one may be agreeably surprised to find that the sound or catheter readily passes through the former stricture into the bladder; its passage may, if necessary, be facilitated by passing a director through the perinæum into the bladder and guiding the catheter along its groove. The urethra once restored to its normal condition and calibre, the artificial opening through the perinæum soon heals up, and, barring the liability of stricture to return if not attended to, the cure may be said to be complete.

"We must not, however, always expect so favorable a result. I have operated in several cases where the obstruction of the canal was complete and impermeability permanent."

"In such cases the patient is condemned to pass his water through the artificial opening in the perinæum unless a new passage should be bored to unite the upper and lower portions of the patient's urethra—an operation which I have seldom or never known to be successful.

"The necessity of micturating through the perinæum may seem to be a considerable hardship, but with a little arrangement the inconvenience is not very great; and be it remembered that the man's micturition is merely assimilated to that of the other sex.

"To keep the artificial passage in a permeable state, it is generally necessary to pass a flexible bougie through the opening occasionally and to retain it *in sitû* for a few hours. The patient very soon learns to do this for himself.

"I have now under my frequent observation two men, on one of whom I operated twenty-five years ago, on the other twenty, and both are thankful for their condition.

"I have not found this operation, with its result in a permanent factitious urethra, at all interferes with the sexual function, although it is, of course, a complete bar to procreation."

I have described fully this admirable operation in the words of its originator, and believe it to be the only form of perineal section that ought to be performed in an impervious urethra. It is not sufficiently known. In exceptional cases the surgeon may examine the urethra itself with the view to find a passage through it, and for this purpose use as a guide to its distal end a grooved staff introduced through the penis down to the obstruction, the two sides of the urethra being held well apart by forceps, or, as suggested by Avery, a loop of silk introduced through each edge of the divided urethra. If the surgeon be fortunate enough to slip a fine grooved director through, the stricture will be readily divided. Under these circumstances a catheter should be passed through the penis into the bladder and the one which had been introduced through the perinæum withdrawn. I need hardly say, however, that it is very rare for the surgeon to be able to trace the urethral passage through the stricture.

Complications of Stricture.

I have thus far dwelt upon *permeable* and *impermeable* organic stricture and its treatment, but have made only passing reference to its complications. I propose now to consider these points more fully, including *perineal abscess*, *extravasation of urine*, and *perineal fistula*, all of which are the direct results of stricture and of local or diffused urinary extravasation.

Extravasation of urine is a complication which will almost necessarily follow a neglected stricture, and the pathological process by which it is produced has been already described. It is one of the means which nature adopts to find an outlet for urine when the natural passage has become so contracted as to forbid its flow. It is a complication of great danger and requires in its treatment great decision on the part of the surgeon, the effect of retained, and often putrid, urine upon any tissue of the body being generally followed by sloughing. The early detection, therefore, of the beginning of an extravasation is important and requires a few remarks.

Perineal Abscess. Symptoms.—If a patient the subject of a stricture appears before a surgeon suffering from more or less severe febrile symptoms, a parched skin, dry tongue, and a rapid irritable pulse, with or without an occasional rigor, a careful examination should be made of the perinæum and the parts around, and, whether there exist any local symptoms sufficient to have attracted the notice of the patient or not, a circumscribed and almost solid mass will probably be discovered in the region of the bulb, which

on firm pressure will be painful. The patient will frequently state that this has existed for some weeks and cannot be the cause of all his symptoms. The surgeon, however, must not be misled, since this circumscribed mass is in effect a urinary abscess the result of a local and limited extravasation, and the symptoms will disappear only when its contents have been evacuated.

Treatment.—If the urethra be examined, the stricture will almost to a certainty be found much contracted and the stream of urine very small. Some discharge from the urethra may perhaps be observed, a little of the pus contained within the abscess behind the stricture making its way by the natural passage. If an instrument be made to pass the stricture, it may then only enter the dilated, ulcerated, and suppurating cavity of the abscess situated behind, and it will be a matter of difficulty to find the vesical end of the urethra, and, as a consequence, the instrument will be passed onward into the bladder in only exceptional cases.

The abscess itself must be opened and its contents evacuated; for if this be not done, it will to a certainty increase, and, being bound down by the perineal fascia, pass backward and spread mischief around the neck of the bladder and in the cellular tissue of the pelvis to the serious injury of the sufferer.

At the same time, the treatment of the stricture is to be remembered, as no treatment can be regarded as scientific if it be not directed to remedy the stricture which is the cause of the abscess.

I am well aware some surgeons are satisfied to open the abscess in the perinæum and leave the stricture to be subsequently treated by dilatation or other means, but such a measure is temporizing; and the soundest and most correct practice is to open the abscess and at the same time to divide the stricture. This is readily done by passing a grooved staff through the urethra into the abscess, if not into the bladder, and freely dividing all the tissues by a scalpel introduced through the perinæum. If the orifice of the vesical end of the urethra can be detected with a probe, a large catheter may be passed and left in; but this point is not of any importance, as by the operation the surgeon is certain that the stricture has been divided, all pus freely evacuated, the possibility of further extravasation taking place prevented, and a free outlet for the urine at the same time been obtained.

By adopting this practice much time is saved, the stricture being treated, and probably cured, by the same means that are absolutely essential for the treatment of the complication.

When, however, perineal abscesses occur unconnected with stricture, they should be opened early to prevent their breaking into the urethra and degenerating into urinary fistula. External urethrotomy under these circumstances is not required.

Extravasation of Urine.—The complication of extravasation of urine does not always appear as a local and confined extravasation or as a urinary abscess. It not rarely shows itself as an extravasation of a severer nature—as one more sudden and marked in its symptoms and more fatal in its effects, requiring also at the hands of the surgeon active and energetic treatment. It occurs as the result of a sudden rupture of the urethra from internal injury or giving way of the walls of an abscess communicating with it, the rupture taking place suddenly during some effort of a patient the subject of a narrow and contracted stricture to relieve his distended and overcharged bladder.

Symptoms.—The symptoms by which the complication is manifested are very marked. The patient will probably relate that during some sudden expulsive effort to pass his urine he felt something give way, and that this sensation was attended with relief to the symptoms caused by the retention of urine. He will soon discover, however, that the relief which he experienced was not the result of a flow of urine from the natural passage, and from the rapid enlargement of the perinæum, scrotum, and penis will be convinced that something wrong has taken place. This swelling will be attended by a burning pain in the parts thus gradually enlarging, and will be increased at each effort made to relieve the distended bladder. The absence of pain on the first onset of the extravasation may delude the patient into a false idea of relief and safety. The surgeon, if now called to see the patient, will find him laboring under retention of urine, with the perinæum, penis, and scrotum more or less swollen, and œdematous from urinary infiltration, the extravasated fluid, perhaps, having made or making its way upward over the abdominal parietes even to the thorax. If the symptoms have existed long, a peculiar inflammation and gangrene of the integuments will make its appearance, and all the constitutional symptoms described as typhoid will certainly be present.

Treatment.—Under these circumstances the surgeon in his treatment has three objects to keep in mind:

First, to free the tissues already infiltrated of their extravasated urine, and thus prevent their total destruction.

Second, to secure a free and ready outlet for the urine from the bladder, and thus relieve the retention and prevent an extension of the mischief.

Third—which is no less important—to cure the stricture, and thereby remove the cause on which the complication originally depended.

The first object is to be secured by free incisions made through the integument into the infiltrated cellular tissue; the second may perhaps be fortunately secured by the passage of a catheter, but this success is exceptional; and in the majority of cases the second and third indications are carried out, either by the external division of the stricture or by the perineal section as just described. A small grooved staff may be passed in by far the majority of cases, the employment of some force being perfectly justifiable to make it pass through the strictured portion.

Urinary Fistulæ.—These may be the result of a urinary abscess bursting in the perinæum or scrotum or the consequence of a more diffused urinary extravasation, the fistulæ, under these latter circumstances, appearing in the perinæum, scrotum, groin, thighs, pubes, or nates (Fig. 409). They are generally the direct consequence of some

Fig. 409.

Urinary Fistulæ the Result of Stricture.

urethral obstruction. Occasionally, however, they follow an accidental wound in the perinæum or urethra or some such operation as lithotomy.

When the fistulæ are simple tracts communicating with a urethra behind a stricture and the tissues through which they pass are healthy, they need not be regarded with any anxiety, as in all possibility they will rapidly heal so soon as the urine flows readily the natural way after the dilatation of the stricture.

When, however, the fistulæ pass through indurated and diseased tissues and are associated with a contracted, if not impermeable, urethra, or are the result of some urinary extravasation and sloughing of the parts, the same success is not always secured.

Treatment.—It is true that in a large number of cases when the stricture is dilated and cured the fistulæ will close, but in exceptional cases they refuse to heal and require the local stimulation of some such escharotic as the nitrate of silver, liquor ammoniæ, tincture of cantharides, the galvanic or actual cautery, to stimulate the indolent passage and assist its contraction.

It should be remembered, however, that in all these cases it is the entrance of the urine into the fistulæ which prevents their contraction and closure, and that any means by which such an occurrence can be prevented will be followed by recovery. To allow the patient to pass his urine is most injurious, and to pass a plugged catheter into the urethra and leave it in will not suffice, as daily experience proves that urine soon flows by the side of the catheter and enters the fistula. The best plan is to have a catheter passed whenever the bladder requires to be emptied; and if the surgeon has dilated the stricture to its full size and instructed the patient to pass an elastic catheter into the bladder, there are very few instances of urinary fistulæ that require further treatment. Where this practice cannot be followed, the introduction of a soft catheter into the bladder, with its end open to allow the urine to flow away as secreted, is to be advised.

When difficulty is experienced in dilating the stricture, Syme's operation may be performed, the surgeon, when he can, laying open the fistula at the same time.

The urinary fistula following lithotomy is best dealt with by the galvanic cautery and catheterism. In these cases, however, the surgeon should always investigate the case sufficiently to assure himself of the absence of a second stone or of a foreign body within the wound, for I have known one case of a sponge, applied to arrest bleeding, being left in the wound and preventing repair. In another a second calculus was overlooked and prevented recovery; the fistula healed when the stone had been expelled by natural efforts through the fistulous perineal opening. I have likewise seen two cases where some calculous formations took place in the wound, and thus kept it open.

Urinary fistula the result of an abscess communicating with the rectum will generally heal as soon as the urine is prevented from entering the passage. The use of the catheter will sometimes effect this; at others, position will suffice. Sir H. Thompson gives a case in which recovery followed the practice of micturating in the prone position for a month. But any means that for a time prevents the passage of urine into the fistula will probably suffice to allow of its contraction. When this does not succeed, the passage may be stimulated by the galvanic or other cautery, and in exceptional cases a plastic operation may be called for.

The urinary fistulæ associated with loss of tissue, whether in penis, scrotum, or perinæum, require the greatest amount of ingenuity in the surgeon, as, besides the constriction of the normal channel, some plastic operation is often necessary.

Cicatricial or Traumatic Stricture.

The difference in the cause, the permanency in the nature, and the difficulties in the treatment of a so-called traumatic stricture have led me to separate the cases thus denominated from that larger class which we have been just considering, the result of local inflammations; and from my notes of forty-three consecutive examples of this kind, in all of which a distinct history could be obtained of some definite accident affecting the perinæum, the blow or fall was immediately followed by hemorrhage from the urethra, with or without other symptoms, and at a later date by difficulty in micturition.

As a rule, these accidents take place in boyhood or in young adult life, though no age is free from the dangers of such an injury; and the kick of a man or a horse on the perinæum, a fall upon a pointed instrument or across a bar, beam, or rail, an injury from a saddle when riding, a blow from a rope, and sloughing of the perinæum after a violent contusion, are the principal causes to which the stricture has been assigned in the cases before me. In one and all there was clear evidence at the time of the injury that the urethra was more or less involved, as hæmaturia in almost every case immediately followed, while difficulty in micturition apppeared subsequently at variable intervals. In some few cases several years had passed away before the attention of the patient was called to the smallness of his stream of urine, when some sudden attack of retention was the first symptom which attracted notice; but in the majority of cases the difficulty of micturition appeared rapidly after the receipt of the primary injury, and went on slowly but surely to increase.

Pathology.—The pathology of these cases is not difficult to understand. The urethra is either partially or wholly ruptured by the injury, the wound being irregularly transverse; union takes place, and subsequent contraction of the cicatricial tissue, with a narrowing of the urethra and the formation of traumatic stricture follow. It is this pathological fact which enables us to explain the obstinacy of the symptoms and the difficulty in the treatment.

Complications.—Traumatic stricture is as liable as any other organic stricture to be followed by complications, these complications being the result of the obstruction to the urethra, in whatever way that obstruction may primarily have been caused. Among my 43 examples of traumatic stricture, 27 were admitted simply on account of their contracted stream and difficulty in micturition; in 8 retention of urine was the immediate cause; in 3, extravasation of urine; and in five urinary fistula complicated the cases.

Treatment.—There are no cases of complicated or non-complicated organic stricture more obstinate in their treatment than the traumatic, and the nature of the obstruction, being cicatricial, is quite sufficient to account for this fact, since it is well known that all cicatrices have a constant and almost perpetual tendency to contract. A traumatic stricture the result of a contracting cicatrix is consequently in its nature essentially a contractile stricture, and its treatment is therefore very troublesome. When treated by dilatation, it will recontract, and even if treated by perineal section or external division, it is far more likely to return than any form of inflammatory stricture.

All forms of treatment are consequently uncertain and unsatisfactory. If dilatation of the urethra is once secured, the introduction of a catheter at short intervals is most essential, or otherwise the canal is certain to recontract; and if it is doubtful whether any case of simple inflammatory stricture is ever really cured, it may unquestionably be asserted that a traumatic stricture will exist for life, and that it will require constant and repeated treatment to preserve even a moderate patency of the narrowed passage. The principles of treatment in both varieties, however, are the same, although the practice may not be so successful.

If the urethra be permeable, the treatment by dilatation should be primarily employed, and persevered in for some time if success is to be secured. If the stricture is so narrow and indurated as to resist dilatation and a grooved staff can be passed through, the operation of external division is the soundest practice and gives the surest hopes of immediate and future benefit.

If the stricture be impermeable and from its narrowness require immediate treatment, or should its complications, either of extravasation or of urinary fistula, demand attention, the perineal section must be carried out in the same manner as in the cases previously referred to.

If extravasation of urine be present as a secondary result of this traumatic stricture, the same principles and practice which have been advocated in the treatment of simple organic stricture are equally applicable, as are also the recommendations which have been made for the treatment of perineal fistula.

In cicatricial stricture where the urethra has so contracted as to render the passage of a catheter impracticable, the establishment of a permanent perineal fistula is sometimes demanded.

The permanent success, however, of the practice in these traumatic cases is not nearly so great as in the inflammatory, although the practice in both is really the same. It is hardly necessary to illustrate these facts, as the experience of all surgeons will bear them out.

To show the greater severity of these cases and the difficulties of their treatment by dilatation, it may be stated that out of the 43 examples of traumatic stricture which have been tabulated, in 6, or fourteen per cent. of the whole number, the operation of perineal section or of external division was absolutely required; whereas, amongst the cases of simple organic stricture, only six per cent. required such operative interference, the simple treatment by dilatation answering every other purpose.

Causes of Death from Stricture.

There are few local diseases which, if neglected, have a more fatal tendency than urethral stricture, and there are none in which the progress toward evil can be so accurately and clearly traced, from the portion of the urethra situated behind the stricture which primarily experiences the evil influence of the obstruction to the bladder, which becomes secondarily involved, and last, but not least, to the ureters and kidneys. The importance of the kidneys in the animal economy as excretory organs receives thus a fresh demonstration from the fatal effects of disease in their structure.

To assert that renal disease is the sole cause of death from stricture would not, perhaps, be strictly true: nevertheless, it is the principal one; and if these glands are not involved, stricture and its complications are not fatal.

Simple uncomplicated stricture is not a fatal disease, few cases terminating in death.

Stricture and retention of urine form a more serious combination, and stricture with extravasation of urine is still more fatal.

It would thus appear that only when stricture has existed for a lengthened period and become complicated does its fatal influence become apparent, the increase in the mortality of the cases increasing with the severity of the complication.

The duration of the stricture has necessarily a serious influence in producing a fatal result: the longer the obstruction exists, the greater the probability, if not the certainty, of the production of renal affection.

In 26 fatal cases, the notes of which are before me, the average duration of the stricture was seventeen years; in 5 symptoms had existed under ten years, and in 10 for upward of twenty years.

When stricture, therefore, has existed for a long period, and more particularly when it has been neglected, it may be inferred with certainty that some disease of the kidneys has been produced and that the slightest injury or accession of mischief is likely to ter-

minate in death, for every subject of renal disease stands, as it were, continually on the edge of a precipice over which the slightest adverse wind may send him; and the fatal results of many operation cases, whether upon the urinary organs or other parts, are to be thus explained, for no subject of renal disease is able to resist the slightest tax upon his powers, and his vital energy sinks irrecoverably upon the receipt of the most trifling injury.

By way of summary of the treatment of stricture, the following conclusions may be drawn:

1. At least ninety-five out of every hundred cases of stricture are readily and safely dilated by means of catheters, and every stricture might be so treated if recognized before any complications appeared.

2. Of *permeable strictures*, it is only in the obstinately irritable and contractile forms that any other treatment is called for; and in these external division by the plan recommended by Syme is probably the best operation, though *rapid dilatation*, *splitting*, or internal division of the stricture may be justifiable under exceptional conditions.

3. Strictures complicated with *urinary abscess* or *extravasation* in which perineal incisions are called for should be treated by external division or Syme's operation when a staff can be passed through the stricture, and by perineal section, Wheelhouse's or Cock's operation, when no such guide can be employed.

4. In strictures complicated with *urinary fistulæ* the stricture itself should be treated, since the fistulæ usually close as soon as the urethra has been fully dilated. When this result does not take place, it is essential that all urine be prevented passing into the fistulæ; and the best means to ensure this is by the passage of the catheter whenever relief is required.

5. The *external division* of the stricture is an excellent operation in obstinate cases of permeable, contractile, and irritable strictures, in all cases of extravasation of urine in which perineal incisions are called for, and also in long indurated strictures complicated with urinary fistulæ.

6. *Perineal section*, Wheelhouse's or Cock's operation, is good in all cases of impermeable stricture or obliterated urethra, complicated or not with urinary abscess or fistula, in which a free outlet for the escape of urine is essential.

7. *Internal urethrotomy*, except in penile or in the obstinately irritable or contractile strictures, is not often required, and the treatment by caustics is dangerous.

8. *Cicatricial strictures* should be treated as others, but they are far more obstinate and require more frequently external urethrotomy.

Ruptured Urethra.

The secondary effects of an injury to or a rupture of the urethra have already been considered under the heading "Traumatic Stricture," and it has been shown that in at least 6.65 per cent. of the cases of organic stricture an injury was the assigned cause. It has also been shown that the worst and most intractable cases of stricture, as well as the majority of examples of obliterated urethra, are of this kind.

I propose now to consider the subject of ruptured or injured urethra, with its immediate effects and treatment. In the majority of instances the injury is caused by some direct violence applied to the perinæum, such as a fall against a post, plank, fence, or chair, a blow or kick on the perinæum. In not a few instances the injury has been produced by the passage of a cart-wheel across the pelvis, although it may be somewhat difficult to understand how such a result can be produced by this cause unless some fracture of the pubic portion of the pelvis coexists; but, explain it how we may, in practice we meet with cases of ruptured urethra following the passage of a wheel across the pelvis and unconnected with any other distinct evidence of fracture.

Symptoms.—The characteristic symptom of a rupture or laceration of the urethra is the passage of blood from the penis unconnected with micturition. The blood appears usually as an immediate result of the injury and may be little or profuse in quantity; it seldom endangers life, and, as a rule, subsides without treatment. If the injury has been but a superficial tear in the mucous membrane, it is just possible that this is the only symptom by which the laceration can be recognized; and if some time has elapsed between its receipt and the calls of nature to relieve the bladder, micturition may be completed with little or no difficulty and convalescence re-established.

It is not often, however, that the subject of a lacerated or ruptured urethra escapes so easily, for in the majority of cases retention or extravasation of urine is the result; and for the relief of this the advice of the surgeon is generally at once sought.

Treatment.—When called to attend a patient who has been the subject of an injury to the urethra suffering from simple retention, the first object of the surgeon is to attempt the passage of a catheter; and if the urethra be not completely torn away and there is not much blood locally effused, there is a strong probability that he will succeed. A gum elastic instrument with a strong stylet should be employed. Having accomplished this, the instrument should be fastened in and the urine allowed to flow away as secreted, being conducted at once by means of a tube into a vessel placed close at hand; for if the catheter be plugged, urine is sure to find its way by its side into the perinæum. If the attempt at catheterism fail, some other means must be employed to provide an outlet for the urine; otherwise, extravasation, with all its danger, will necessarily follow. Under these circumstances an incision into the perinæum on a grooved staff passed down to the seat of laceration in the perinæum is unquestionably the soundest practice to adopt, as by this means the extravasated blood and urine find a ready outlet, and the bladder, when it contracts, a vent for its contents, the danger of extravasation of urine being thus prevented.

When the perinæum has been laid open and the two ends of the divided urethra can be made out, they may be brought together by a suture; and if the orifice of the vesical end of the ruptured urethra can be found with a grooved probe, a catheter should be passed, the instrument having been first introduced through the penis, and subsequently guided upon the grooved probe into the bladder. If difficulty is experienced in finding the orifice, there need be no alarm, as it is quite clear that the urine will readily find its way externally through the artificial wound; nevertheless, an early attempt to pass the catheter should certainly be made, as it is most important that the continuity of the urethra should be restored as early as possible.

When a catheter has been introduced, it must be left, since the patency of the canal should be maintained *during* the whole period of its repair and its subsequent contraction in a measure neutralized.

The frequent passage of an instrument *after* the repair has taken place is an important point to be observed, this practice being the best guarantee that a cicatricial stricture cannot ensue. In the case of a man I treated seventeen years before for retention following a ruptured urethra by a perineal incision there has not since been any difficulty in micturition.

RETENTION OF URINE.

When a patient is unable to pass his urine, he is said to be the subject of retention, which may be due to the presence of organic or cicatricial stricture, spasm of the urethra, urethral obstruction from inflammation of the urethra or prostate, urethral calculus, and many other local and general causes. Amongst the latter must be placed brain disease, and my friend Dr. Hess of Finsbury Square told me in 1879 of the case of a gentleman who had a bladder so dilated that it reached up to the ensiform cartilage and led the medical man in attendance to believe that *ascites* existed. There was, at the same time, very marked anasarca of the lower extremities up to the groins. All these symptoms, however, disappeared when ten pints of urine were drawn off.

I have already stated that retention existed in 129 out of 608 cases of organic stricture admitted into Guy's during seven years, and in 8 out of 43 cases of traumatic stricture. It was also present in 80 other cases, the result of varied general and local causes unassociated with stricture. Spasmodic stricture was the assigned cause in half—*i. e.*, it was found in subjects in whom no permanent narrowing of the canal existed. In almost all excess of drinking, with or without exposure to wet and cold, was the exciting cause, and no complication aggravated the cases. One was in a boy æt. 10 who paid the penalty of a drinking-bout by suffering the pain of a retention. Catheterism relieved him. In all these 40 cases spasm of the muscles of the urethra was the assigned cause.

Retention in a child is generally from stone impacted in the urethra; in an adult, from stricture; and in an old man, from prostatic disease.

Spasmodic Stricture as a Cause of Retention.

The existence of a *true spasmodic stricture* is no longer a subject of doubt. That the seat of the stricture is the membranous portion of the urethra, which is encircled by muscles, is also now generally acknowledged, and that the usual exciting causes are exposure to wet or cold and excess in drinking many cases before me clearly prove. Anything, however, which can induce an altered or acid state of the urine is likely to be followed

by this complication, gouty and rheumatic patients being particularly liable to such attacks.

Treatment.—The treatment of such cases is not difficult, the simple passage of a large metallic catheter being the most expeditious and certain practice. The instrument should be well warmed and freely oiled, and then passed slowly, so as not to excite alarm or increase the spasm of the muscles. In skilful hands its introduction is not an operation of difficulty. If, however, the operator be foiled in his endeavors, he must be cautious not to employ force, which is never required and never justifiable. An anæsthetic should then be administered, and with a patient fully under its influence all obstruction ceases, while the instrument will pass into the bladder. If there be an objection to the use of the anæsthetic, the old remedy of *a hot bath* cannot be too highly extolled, few patients suffering from simple retention failing to micturate when thus immersed; by the bath the introduction of a cathetre is likewise much facilitated. *A full opiate* is also an invaluable remedy, relieving the involuntary contraction of the bladder which is so painful in cases of retention, and thus removing one of the most constant causes of spasmodic stricture. The value of opium in these cases, according to some, cannot be upheld too strongly; indeed, they assert that there is no case of retention of urine which will not yield to its benign influence, allowing either a natural relief or the introduction of a catheter. The inhalation of an anæsthetic I believe to be a preferable remedy, its action being more rapid and certain. If failure follow the application of these, other measures must be adopted; and without doubt the simplest, safest, and most expeditious practice is puncturing the bladder. I prefer to do this through the rectum; others, above the pubes. In a simple spasmodic stricture, however, such a necessity can scarcely arise.

Inflammatory Stricture as a Cause of Retention.

It has been already shown that in spasmodic stricture exposure to wet or cold and an altered condition of the urine, produced from either excess of drinking, gout, or rheumatism, are the chief exciting causes of an attack of retention; and if this be true, there can be no difficulty in understanding that a like result may be brought about and is more liable to be experienced if the urethra itself should be the seat of an inflammatory action. Retention of urine occasionally comes before our notice as a result and concomitant of gonorrhœa. The causes of the retention are evidently compound—viz., spasmodic stricture, and the mechanical obstruction produced by the œdema of an acute inflammation combining to produce the result.

Treatment.—The treatment required to afford relief must be based upon the appreciation of these two conditions which have combined to cause the effect. The retention is in a measure mechanical, and must be met by mechanical treatment, but it is also functional, and, as a consequence, must be so considered.

The symptoms being urgent, time is, therefore, a great object; and if called to a case there are few surgeons who would not at once attempt to pass a catheter. Let the surgeon choose an instrument of medium size, No. 4 or 5, being the best, taking care that it be well warmed and oiled, and then with gentleness, and yet with firmness, the obstruction may be overcome; *arte non vi* must be the guide to action, as force is to be condemned as much in these cases as it was in the preceding.

If these means fail, a hot bath and a full opiate are the soundest remedies. They relieve the local turgescence of the passage, and also the obstruction, and with it the associated spasm. In some instances the introduction of a piece of ice into the rectum serves a like purpose. The use of an anæsthetic in these cases cannot be recommended, as it merely relieves the spasm, but does not alter the condition upon which the spasm depends—viz., the inflammation. When these means fail—which is not commonly the case—some operative measure may be required, which will be dwelt upon in another page.

Retention of Urine following a Blow in the Perinæum.—Under this heading it is not my intention to allude to cases of ruptured urethra, as this condition has already been considered. But cases of retention occasionally come under notice which follow a simple contusion in the perinæum. I possess three such records—two in children aged three and seven respectively, and one in an adult aged twenty-nine. In none of these cases could hemorrhage or other symptom of ruptured urethra be made out. The retention followed the contusion and was caused by some spasmodic condition of the passage excited by the injury. In all the cases the simple passage of a catheter was the only treatment, and with the relief of the symptoms convalescence followed.

Retention of urine from the pressure of an abscess in the perinæum must be mentioned, as cases of retention from such a cause occasionally come under notice, while abscess about the rectum is not unfrequently associated with such a difficulty. It should be treated by opening the abscess.

Paralysis of the bladder from any cause situated either in the organ itself or associated with spinal disease is a common cause of retention, and the same complication may be found in fever or other constitutional condition in which the vital powers of the patient have been much reduced and the nervous system has, as a consequence, become unable to answer to its accustomed stimulus. Retention of urine is also met with as a symptom of peritonitis, local or general, or as a result of some other abdominal disease. It is well for the surgeon to remember that this complication may be produced by the causes enumerated.

It is not to treat retention of urine, however, that the surgeon is usually called to such cases, but for the incontinence of retention, the incontinence being merely the overflow of an already overdistended and engorged bladder. The symptom of incontinence is a very positive one and should never mislead any practitioner. It is almost always a concomitant and result of retention, and at any rate should be so regarded until the surgeon has convinced himself by a careful examination that the bladder is not distended.

Retention of Urine as a Symptom of Enlarged Prostate, and in the Aged.

It has been a common opinion, held by all surgeons for many generations, that an enlarged prostate is a very general condition of old age, and retention of urine, as a consequence and symptom of this affection, is of frequent occurrence. The investigations of recent pathologists have shown, however, that such an opinion is by no means correct; for although an enlargement of the prostate, either as an hypertrophy or from the development of independent prostatic glandular tumors, may take place—and when it does, it is most commonly met with in old people—yet such a condition is by no means to be considered as a necessary senile change.

Treatment.—When retention of urine takes place in old people in whom no stricture exists, it is too frequently ascribed to this chronic enlargement of the prostate, and, as it is really a rare thing to find such a condition in the bodies of those that die, it is fair to believe that this retention is due to other causes, such as atony of the bladder, which may be relieved by the introduction of a large catheter. This operation should always be undertaken with great care, as an injury to the prostate or bladder in old people is of considerable consequence. An elastic instrument with a full curve, in the hands of those who are not in the constant habit of using instruments, is to be preferred, and this may be passed slowly down to the neck of the bladder. It is at this point that the difficulty in its introduction is always experienced; but if the index finger of the left hand be introduced into the rectum and the end of the instrument tilted upward by the slightest pressure with the right hand, the catheter, as a rule, will be readily passed onward, and relief will be secured. The patient's pelvis should always be well raised before the catheter is used.

Retention of urine may also be produced by an abscess situated in the prostate gland, and the retention is relieved only when the abscess is opened. This treatment, therefore, is that which should be followed.

Retention of Urine as a Result of an Elongated and Adherent Prepuce.

It is a somewhat inexplicable fact that surgical writers have, with rare exceptions, omitted to notice that an elongated prepuce and adhesion of the glans penis to its mucous membrane covering is capable of producing retention of urine with every symptom of vesical irritation; yet few surgeons can have had much experience at any hospital or dispensary, particularly in out-patient practice, without seeing many such examples. I could quote cases in which an adherent prepuce had been the cause both of retention and of incontinence of urine, and in which it had produced symptoms of irritable bladder and every other symptom of vesical calculus, even hæmaturia, prolapsus recti, or constant priapism.

All, or nearly all, these cases take place in early life, and I never see a case of vesical irritation in a male child without first examining the condition of the penis. I have been

in the habit of pointing out this fact to students for some years, and have advised them to follow the practice suggested, under the conviction that in at least two-thirds of the cases suffering from urinary irritation which pass under observation an adherent and elongated prepuce is the sole cause.

Treatment.—Circumcision and the careful separation of the prepuce from the glans penis, with the removal of the confined secretion of Tyson's glands, is the only remedy, which is at once simple and complete.

Retention of Urine from Organic or Cicatricial Stricture.

Among the many contingencies to which a patient suffering from organic stricture is continually exposed, none cause more agony and alarm or demand more prompt and decisive action on the part of the surgeon than retention of urine.

The retention may be the result of a slowly-contracting organic stricture, but it will probably be produced by some sudden accession of spasm of the muscles of the passage, and thus be compound in its nature, a spasmodic being grafted upon an organic stricture. The symptoms, however, are necessarily urgent; and it becomes an important question as to what practice should be pursued.

Treatment.—With this object it will be of interest to inquire, first of all, what practice has been proved of value, and as a means to the solution of the difficulty I can show that out of 224 examples of retention from simple organic stricture, 184 were successfully treated by means of catheterism, warm baths, and opium. In 40 cases only, or 17.4 per cent., were any other operative measures called into requisition, and in all of these 40 examples the bladder was punctured *per rectum* with complete success and without any of the theoretical objections which have been adduced against the operation.

Out of 14 cases also of retention of urine produced by the gradual contraction of a *traumatic* stricture, 8 were treated by means of catheterism and 6 by puncture of the bladder, the proportion of cases requiring such an operation being much greater in traumatic strictures than in the preceding class of simple organic stricture, the cause of this difference being very apparent.

If a surgeon is called to a patient suffering from retention of urine produced by either a simple spasmodic or an inflammatory stricture, it has already been explained that relief can be obtained by the cautious introduction of a catheter, aided, if required, by the use of the warm bath or a full dose of opium, and in certain cases by the inhalation of an anæsthetic. If these means fail, as experience proves may be the case, either from some peculiarity of the stricture or from the manner in which the treatment has been carried out, other measures will necessarily be called into requisition; and it has been already stated that the best and most expeditious practice is to puncture the bladder through the rectum. It is true that this practice is rarely needed in simple spasmodic or in inflammatory stricture, for in the majority of cases the means already suggested are amply sufficient to secure relief; nevertheless, in exceptional instances this operation is of great value. It must be remembered, also, that the practice is required only when simpler means have failed.

Since the introduction of the "aspirator" many surgeons have employed it with success in cases of retention, but relief by such a measure does not commend itself to my mind, being merely a temporizing operation and requiring frequent repetition in the same case; it has no such influence for good upon the cause of the retention as the operation of puncturing the bladder through the rectum. In exceptional cases of retention of urine it may be a justifiable proceeding.

In the treatment of retention of urine with simple organic or traumatic stricture the same principles of practice should be applied as have been recommended in the former class of cases, and in a large proportion of instances it has been already shown that success by such treatment may be secured, since, out of 238 cases of retention admitted into Guy's, operative measures were required in only 46, and the simple introduction of a catheter, with the aid of warm baths and the internal administration of opium, proved sufficient to carry out all the objects required in 192. If the surgeon is called, therefore, to a case of retention of urine with organic stricture, the introduction of a catheter is the primary means to be employed. If the history informs him that the retention is the result of a gradually contracting passage, a medium-sized instrument should be selected, and on this failing a second attempt, with a smaller one, may be followed by success. Force, however, must not be employed, and too much time should not be expended in making the attempt. If success is to follow the operation, it will readily be obtained;

perseverance and repeated endeavors to pass an instrument, as a rule, do harm. If the symptoms are not very urgent and some delay may be allowed, the warm bath and a full opiate, such as two, or even three, grains of opium, may be employed, and under their combined influence it will be only in exceptional cases that relief will not subsequently be secured.

If the symptoms of retention, however, are very urgent and the agonies of the sufferer demand immediate relief, or if the means which have been just described have been found wanting after a fair trial, there is little doubt that the most scientific and certain practice is the puncturing of the bladder through the rectum; for all experience has correctly endorsed the opinion expressed by Mr. Cock when he recalled the attention of the profession to this operation in his valuable paper published in 1852 (vol. xxxv. of the *Med.-Chir. Trans.*)—"that the bladder may be reached with the smallest amount of pain, with the least risk of present or future danger, and with the greatest prospect of ulterior good, by puncture through the rectum."

The records I possess of the cases of this operation positively prove the truth of this opinion, and it is gratifying to find that in these days many surgeons recognize the value of the practice.

The operation is as simple as it is safe, and as efficient as it is scientific. As a means of relieving a patient from the agony of retention of urine which has been proved to be irremediable by the *rational* use of catheters it stands unrivalled. By its adoption all forcible catheterism, with its dangers, is avoided. Perineal section and its difficulties as a remedy for retention are done away with, and the operation for puncturing the bladder above the pubes may nearly be forgotten. Puncturing the bladder through the rectum embodies in itself all the advantages of these means, without any of their evils, and on practical grounds commends itself for our adoption.

I would add, therefore, as a final conclusion, "that in all cases of retention of urine from stricture in which relief cannot be given by means of rational and not forcible catheterism, and in which the use of the warm bath and opium have failed, the operation of puncturing the bladder through the rectum should be performed.

Puncture of the Bladder per Rectum.

In all cases of retention of urine in which relief cannot be afforded by the introduction of a catheter, and the nature of the obstruction is not such as to require the operation of urethrotomy, puncturing the bladder through the rectum is the right operation to perform, as by it relief can be given with rapidity, certainty, and safety.

In former times the bladder used to be punctured with a full-sized trocar and canula from the perinæum, but such a clumsy operation is not now recognized among surgical proceedings, though with the aspirator the same proceeding has been often undertaken. At the present day some surgeons prefer tapping the bladder above the pubes, but in safety and efficiency the operation is not to be compared with that which I now recommend, for, in the words of its modern advocate, Mr. Cock, "the operation is safe, easy of accomplishment, and without danger as to its consequences. In cases of retention which resist ordinary treatment it is greatly to be preferred to the long-continued attempts at catheterism, which, whether successful or not, must be infinitely more injurious to the urinary organs than the simple and almost painless operation of tapping."

"I consider," writes Cock, "that the benefit of the operation consists not merely in the immediate relief given to the patient, but also in the opportunity which it affords, by the retention of the canula in the bladder through an indefinite period, of diverting the flow of urine from its ordinary channel, and thus giving quiet, freedom from pain, and the natural means of restoration to the maimed, irritable, or diseased urethra. I conceive also that the bladder might be tapped with advantage in cases of obstinate stricture in which retention of urine does not actually exist."

These views, published by Mr. Cock in 1852 (*Med.-Chir. Trans.*, and *Guy's Reports*, 1866), I cordially endorse. The practice of Guy's Hospital, to my knowledge, has only confirmed their accuracy; and the more I see of the operation, the more I like it. The objections raised against it are theoretical, and not practical; for abscesses between the bladder and rectum, persistent fistulous openings, injury to the seminal vesicles, and wounds of the peritoneum do not commonly occur. They are said to have done so in exceptional instances, but such must indeed be very rare. Mr. Cock, in his large experience, has known but one bad result to follow the operation, and that was atrophy of the testicle, from which he infers that the vas deferens was wounded. At Guy's, from the

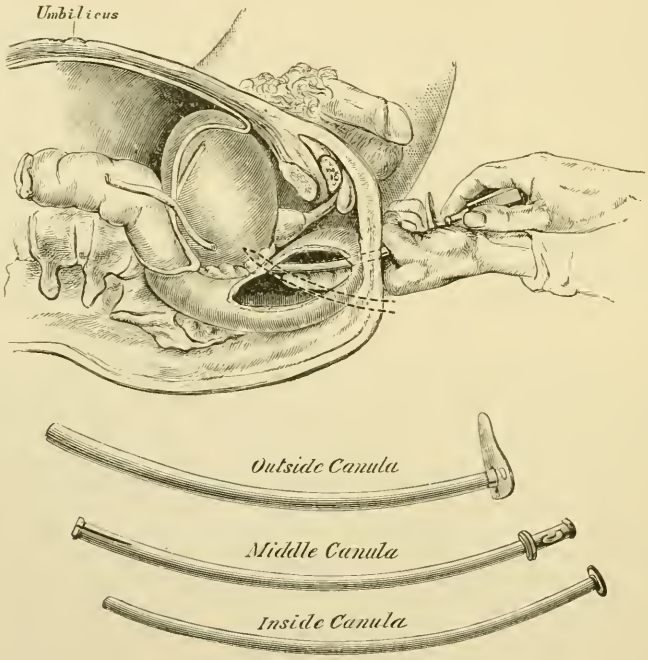
carelessness of a house-surgeon, a fatal peritonitis from the perforation of a coil of intestine once followed the operation, the puncture having been made too far back; but, eliminating carelessness—a cause of half the errors in surgery—the operation is very safe.

The only requisite is a moderately full bladder—a feature always present under the circumstances which call for the operation. An enlarged prostate is no real obstacle to its performance, since it may be perforated with impunity.

Operation.—The best instruments are those suggested by Mr. Cock. The long curved trocar and canula, as originally employed, are inefficient instruments; indeed, many of the objections to the operation are probably traceable to their use. Cock's instruments consist of a canula six and a half inches long, a blunt pilot trocar, and a sharp trocar, a second tube with an expanding end to keep the canula in position, and a third to maintain the second in position (Fig. 410).

The patient should be placed and held in the position for lithotomy and brought well to the edge of the bed. The operator must then introduce the index finger of the left hand into the rectum with the palm upward to feel for the prostate (Fig. 410), and, if

Fig. 410.



Operation of Puncturing the Bladder per Rectum.

possible, for the bulging base of the tense bladder beyond. Some little pressure above the pubes may help in this attempt. The pulpy point of the index finger is then to be held in the median line, just below the spot at which the puncture is to be made. The surgeon then with his right hand is to take from his assistant the canula, well oiled and fitted with the *blunt* pilot trocar, and to introduce it into the rectum upon his left index finger, passing it well up to the point selected for puncture. He should then steady the canula and hold it firmly in position with the thumb and three outer fingers of his left hand, and withdraw the blunt trocar. The *sharp* trocar can then be introduced through the canula, and, having reached its end, the handle with the canula is to be depressed and driven home, in a direction upward and forward, *in a line toward the umbilicus* (dotted line, Fig. 410). The bladder in this way will be entered, the free end of the instrument moving freely, and all resistance ceasing. The trocar should then be withdrawn and the canula pressed well home. Before the bladder is completely emptied it is well to insert the two inner canulæ and fasten the whole in by means of tapes, two passed in front and two behind the thighs, to a girth round the waist. The canula may then be plugged with a peg, to retain the urine, or with a hollow plug inserted into a piece of india-rubber tubing, through which the water may drain away.

As soon as the urethral passage has become pervious to the catheter, *but not before*,

the canula should be withdrawn; this condition usually takes place within a week from the introduction of the catheter. In a case of mine the canula was left in for seven weeks before a catheter could be passed, when a rapid cure ensued. The stricture may then be treated on rational principles by dilatation. It is very remarkable how at times a stricture which has thus been left alone and unirritated by catheterism or ineffectual natural efforts at micturition, gives way under such treatment, and a thoroughly impervious indurated urethra becomes pervious and amenable to simple measures.

The wound into the bladder closes rapidly after the removal of the canula, even after many weeks, and in a case of my own no urinary fistula followed the presence of the canula for seven weeks.

In retention of urine from enlarged prostate such an operation as this is rarely called for, yet at times it is necessary. It was performed at Guy's in two out of twenty-four cases of retention of urine from this cause, and with complete success. I have had recourse to it on three occasions where the neck of the bladder and prostate gland had been seriously injured from rough catheterism, and with such good success that I shall never hesitate to repeat it when any difficulty exists in entering the bladder or in subsequently keeping an instrument in the bladder. In two of the cases mentioned the irritability of the bladder was so great as to resent the presence of an instrument, and the pain and difficulty in its passage were so severe as to be nearly unendurable. In both the operation was followed by speedy and permanent relief; the bladder recovered its healthy condition after the parts had had rest for a few days, the urethra allowed of catheterism without distress, and convalescence was soon established.

I know of no operation attended with equal good that is so safe, satisfactory, or free from danger. The surgeon may perform it without fear in all cases of retention where any difficulty in catheterism exists.

In all cases of supposed retention of urine the surgeon should guard himself against falling into the error of mistaking suppression for retention, as in all cases of supposed incontinence he should remember that it may be due to retention and overflow.

Supra-Pubic Puncture of the Bladder.

This operation has been growing in favor and claims description. Mr. T. Smirth[1] asserts "that, while it is as safe as the rectal puncture, it is easier of performance," and that "it is applicable to all cases of retention in which the bladder rises above the pubes."

In corpulent subjects, and in such alone, the skin should be punctured with a knife, to facilitate the entrance of the trocar.

Whilst the urine is in full flow it is wise to introduce through the canula a gum-elastic catheter with a terminal as well as lateral orifice, the former allowing the passage of a stylet into the bladder to serve as a guide for the introduction of a fresh instrument. The catheter should be firmly secured in position by means of threads attached to a belt of strapping and plugged, and for permanent wear fitted with a soft rubber or vulcanite shield. Were I to perform this operation I should probably raise the bladder out of the pelvis by distending the rectum with the dilator as described at page 640, Fig. 363.

Extravasation of Urine in Children, and Retention from Impacted Urethral Calculus.

It has been already explained how retention and extravasation of urine in the *adult* may be produced by the mechanical obstruction of a urethral stricture. It remains to show how in children the same effects ensue from a mechanical obstruction of a very different kind. I allude to the obstruction caused by a urethral calculus.

A vesical calculus, when small and ejected from the bladder, may become lodged or impacted in any portion of the urethra, and as a consequence give rise to every degree of difficulty of micturition, even to a retention of urine and extravasation. In adult life I have seen complete retention, but I have never seen extravasation occur as a result of impacted urethral calculus. In infancy and childhood, however, almost all the examples of extravasation of urine that have passed under my observation have been the product of such a cause; I have seen it in an infant fourteen months old, and in many others older. When a case of retention in a child comes under notice, and there is no phimosis,

[1] *St. Barth. Hosp. Rep.*, 1881, p. 294.

paraphimosis, or adherent prepuce by which this symptom may be produced, a strong probability exists that a urethral calculus is the cause.

Treatment.—If the calculus can be removed by forceps carefully used, this practice is the right one to adopt; it is, however, rarely successful, and where these means fail the stone must be excised. When extravasation has taken place, the urethra must be opened in the perinæum by a free incision upon a grooved staff. The stone is sometimes lost in the sloughing tissues.

Summary.—By way of summary of the causes of retention, it may be stated that retention in a *male child* is usually due to a urethral calculus, phimosis, paraphimosis, adherent prepuce, or the mechanical obstruction caused by a piece of string, etc.; in a *female*, to ulceration about the meatus or to adherent labia; retention in the *young adult*, to stricture, obstruction of the urethra from stone, gonorrhœa, perineal, anal, prostatic abscess, or rectal disease; in the *aged*, from enlarged prostate or atony of the bladder.

Retention from fever or general nerve shocks may occur at all periods. In women hysterical retention may also occur, as well as retention from uterine causes.

Urethral or Urinary "Shock" and "Fever."

Surgeons have long been familiar with the fact that after the passage of a catheter certain male patients experience symptoms which seem to be altogether irreconcilable with the simplicity of the operation that apparently excites them. They have known that immediately or soon after the easy passage of a catheter and micturition a man may shiver and turn pale and cold, or perhaps faint, turn sick, or vomit—that he may even have a slight epileptic convulsion and soon recover, the "shock" either passing off or being followed by a more or less severe febrile condition.

Mr. Banks and others have also pointed out how after the same simple exciting cause a man may suffer from "shock" of so severe a character as to terminate in death within twenty-four hours, or become the subject of a "continuous" or "intermittent" attack of fever which may or may not terminate in speedy death, the symptoms under these circumstances assuming a shape of either uræmic or septicæmic poisoning: and in these cases, when suppurative urethral or kidney disease in any of its forms is made out to exist, there is no difficulty in finding an explanation of the "shock" or of the "fever."

Since the days of Richard Bright, and more particularly the publication of Dr. N. Chever's valuable paper on the causes of death after injuries and surgical operations (*Guy's Hosp. Reports*, 1843), surgeons at Guy's have accepted as truisms "that an operation or injury in itself of a most trivial kind is liable to be followed by fatal results should the subject of it be suffering at the time from either acute congestion or granular degeneration of the kidneys;" "that it is impossible to urge too strongly the necessity of testing the urine for the presence of albumen in each patient before deciding upon the performance of any surgical operation," however trivial it may appear; and that an operation upon the urinary organs of the simplest character must always be regarded as most dangerous when kidney trouble complicates the case, as well as when the patient has been long under the influence of tropical malaria, as pointed out by Sir J. Fayrer.

But this explanation of the symptoms cannot be given for all cases, and we must accept as true to a degree Sir A. Clark's recent assertion "that in persons apparently healthy catheterism is sometimes followed by fever neither distinctly uræmic nor distinctly pyæmic, that this fever sometimes ends in death, and that in such cases the autopsy reveals no definite visible structural lesion adequate to account for death."[1]

Under these circumstances we of necessity go to the nervous system as the one at fault, and recall the anatomical fact which "Müller long ago demonstrated—that the nervous supply of the penis, prostate, and neck of the bladder is almost purely sympathetic, the nerves being traceable to the pelvic or inferior hypogastric plexuses,"[2] and acknowledge that such plexuses are as susceptible to shock as are the abdominal.

Other points also in urethral or bladder troubles favor this view; for instance, medical men must often have observed that with contraction of a distended bladder, on the expulsion of the last drops of urine a shudder constantly passes through the healthy frame, and I well remember the case of a lady about thirty years of age who had the severest rigor I ever witnessed as the direct and immediate effect of the bladder emptying itself after a long enforced retention.

Again, in a case of rapid lithotrity I had in 1883 in a man aged fifty-nine, from whom two hundred grains of uric acid calculus were removed without difficulty or the slightest

[1] *Edin. Med. Journ.*, April, 1884. [2] Mr. Banks's paper, *Edin. Med. Journ.*, 1871.

hitch in forty-five minutes, and where a good result was with confidence predicted, the patient in forty hours sank collapsed, the collapse not following the operation, but showing itself within the first twenty-four hours. After death perfectly healthy kidneys were found and an uninjured empty healthy bladder. In fact, no pathological cause of death was detected.

In all these cases "shock" was manifested, and shock without fever, the "shock" in its mildest form showing itself in the shudder of normal evacuation, in its more severe in the evacuation of retention, and in its most severe and fatal form in that following a somewhat prolonged, though apparently not violent, operation.

I hold, therefore, that "urethral shock" as well as "urethral fever" is met with in certain patients the subjects of urethral and bladder affections, and that probably both shock and fever are brought about through the influence of the sympathetic system; that the shock may be only a passing shudder or faintness, but that occasional rare cases occur where the nervous shock is so profound, even after the simple introduction of a bougie or catheter, that death may result within twenty-four hours; that urethral fever may assume any degree of intensity, from a slight rigor, and subsequent general *malaise*, to such serious prostration as may end fatally after some days; that a careful distinction must be made between true urethral fever and pyæmia resulting from operative interference with the urinary passages; that renal disease, with its resulting vitiated condition of the blood, probably predisposes to death, as it unquestionably is one of its causes in such cases.

It will be seen that these conclusions coincide to a degree with those given by Mr. W. M. Banks in his able paper already referred to.

Treatment.—The surgeon should ever have before him the possibility of a patient requiring the passage of a catheter being prone to suffer from urethral "shock" or "fever." He should, therefore, where possible, prepare him for the ordeal by clearing out the bowels and keeping him warm and quiet for twenty-four hours, and, in many cases, in bed. Where any malarious fever has previously existed a good dose of quinine—say five grains—should be given a few hours beforehand; and even when no such history can be obtained, a like practice has advantages. Should the patient have any external appearances of renal disease and albumen be found in his urine, the surgeon should not pass a catheter without these precautions unless under the pressure of urgency.

Under all circumstances the catheter must be clean, warm, and well anointed with some antiseptic oil. It must be used carefully and tenderly. Should the bladder be much distended, part of the urine should be drawn off at the time and the remainder at a later period; and if the contents of the bladder are fetid and the organ requires to be washed out, some little of the injected antiseptic fluid should be left behind in the bladder. When a soft instrument can be used, it should be preferred. When "shock" is caused by the manipulation, the warmth of a bed, with some external appliance to the extremities, and the administration of a wineglassful of hot spirit and water, often acts well.

When slight febrile disturbance takes place, a dose of Dover's powder or the bromide of potassium is very useful.

In more chronic cases quinine and iron, combined or separately, are of great value, as also are vapor or hot-air baths. When the symptoms are continuous or recurring, renal disease is to be suspected, and the treatment must be conducted under such a light. The prognosis of these cases always turns upon the persistency or frequent recurrence of the symptoms and the elevation of the temperature, together with the indications afforded by the daily careful examination of the urine.

CHAPTER XXIV.

AFFECTIONS OF THE GENITAL ORGANS.

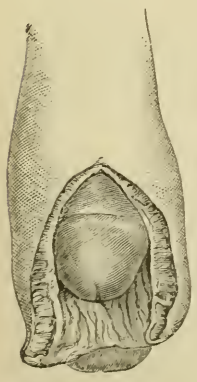
There is probably no part of the body which varies more in its conformation than the penis, or one in which any congenital defect is more likely to be inherited. The elongated and contracted prepuce is particularly hereditary, and all the male branches of a family may be the subjects of it. I have known this to be the case in many instances, and in one family five sons suffered from it, as well as their father.

Phimosis, or a condition of prepuce which, either from narrowness of the preputial orifice or from adhesion, cannot be retracted behind the glans, is sometimes a *congenital* affection, but as often as not it is an *acquired* one, the result of inflammatory thickening and contraction subsequent to a preputial chancre or other trouble.

So long as the prepuce is only long and the glans can be uncovered for purposes of cleanliness and during erection operative interference is not called for, though it is well to impress upon nurses the necessity of paying attention to the infant's penis and of cleaning it daily, since a want of such attention is frequently the source of urinary trouble and penile irritation. From neglect the secretion of Tyson's glands collects behind the corona and acts as an irritant; the prepuce and glans penis as a result constantly become adherent, and, as a consequence of the irritation, bladder symptoms, simulating those of stone, appear. (*Vide* page 632.) In some neglected cases an acute inflammation is induced, followed by œdema of the prepuce and the secretion of pus, which suspicious minds have too often interpreted as gonorrhœa, much to the injury of nursemaids and others in whose charge the child rested. This disease is essentially a balanitis and is easily cured by cleanliness. In the adult a long and narrow prepuce is injurious, as being a bar to proper cleanliness and interfering with coitus or rendering it painful. It is also, without doubt, an exciting cause of cancer of the organ where a disposition to such an affection exists. In boyhood it may, by exciting an irritation in the parts, induce a habit which ends in masturbation. It often gives rise, moreover, to incontinence, and may produce retention of urine. Dr. Lewis Sayre of New York has also pointed out in his work on *Orthopedic Surgery* (1876) that as a direct result of this condition of the prepuce talipes, paralysis, and other nervous affections may take place, the talipes being due to muscular contraction of the lower extremities owing to reflex nerve irritation, and paralysis as a consequence of nervous exhaustion caused by the undue genital excitement which is often associated with this condition.

Treatment.—When the narrowing is not great, the daily retraction of the prepuce over the glans for purposes of cleanliness is generally sufficient to dilate the orifice, care being taken to replace it subsequently. Dr. Cruise's plan of dilating the orifice mechanically is not satisfactory; I have given it a trial and rejected it. The suggestion, also, of making two partial lateral sections of the mucous membrane has in my hands met with the same fate. Neither of these methods is so successful as to warrant its being recommended.

Fig. 411.



Operation for Phimosis.

When phimosis exists, congenital or otherwise, it is, as a rule, best treated by circumcision. In exceptional cases, where a narrowing of the prepuce is more marked than an elongation, the prepuce may be slit up (Fig. 411), but in children circumcision is the better operation. In some instances, however, where the penis is very short, the fault resting more in the penis itself than its skin covering, circumcision should not be performed, for I have known, under these circumstances, the operation to fail, even when well done; in such cases the prepuce should rather be slit up to the corona, and its mucous covering turned well back and fixed to the skin.

In minor cases the *slitting* plan should be carried out, the skin and its mucous lining being divided in the middle line either by the introduction of a bistoury guided by a director beneath the prepuce or by means of a pair of sharp scissors. The surgeon must be careful, in doing this, to divide the mucous membrane *right back to the corona.* In the adult he should then turn the two flaps backward and fasten the mucous to the skin flap by means of some fine carbolized catgut sutures. In the infant there is no

necessity to stitch. When the prepuce requires division to expose a sore or some warty growth, the above plan should be selected.

Circumcision is an operation that requires great nicety, for it fails if sufficient skin is not taken away and the mucous covering of the glans is not fully divided up to the corona, and it does not turn out well when too much skin is removed. It is by no means a dangerous operation, although in "bleeders" it may be so, Grandidier (*Die Hämophilie*, 1855) recording seven cases of Jewish children who died from preputial hemorrhage after circumcision. The following is the plan I have for years adopted and taught, and have never known to fail if properly carried out:

The first point is to decide how much skin is to be removed, which can satisfactorily be determined by applying a pair of long dressing forceps to the skin of the penis whilst it rests in the natural position, on a level with the corona, and closing them as soon as the glans penis has been allowed to slip backward. The integument in front of the forceps may then be amputated with a scalpel (Fig. 412).

Fig. 412.

Operation for Phimosis. (First step.)

The forceps should now be taken away and the mucous covering of the glans be divided in the middle line, well up to the corona (as in the slitting operation), and turned backward, the two flaps being stitched to the skin by fine sutures. In adults a fine uninterrupted suture is probably the best; in infants a strip of dry lint wrapped round the parts is all that is necessary.

The glans penis, in this as in the former operation, should be completely separated from its mucous covering, all secretions removed, and the frænum divided when short.

By adopting these suggestions the student has a definite guide to aid him in the removal of the skin; whereas, if the end of the foreskin be drawn out, as usually recommended, he has none.

"Circumcision is practised amongst the Tongans (Friendly Islands), not as a religious rite, but principally because the women won't have the men who are *un*circumcised, and they have to remain unmarried" (J. E. Moulton, *Wesleyan Missionary*, February 26, 1880).

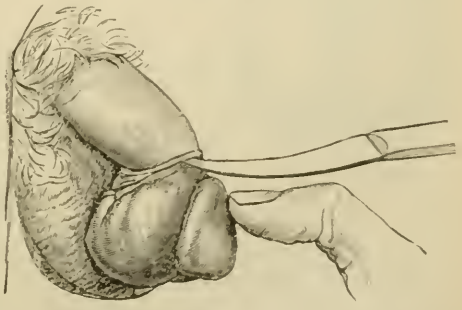
Paraphimosis is said to exist when a tight prepuce which has been retracted behind the glans cannot be replaced, and as a consequence a strangulation of the glans and mucous lining of the prepuce with œdema takes place, and at a later period ulceration in the line of strangulation, and even sloughing.

In children it follows the accidental retraction of a narrow prepuce, and in adults the mechanical retraction of the prepuce during coitus and the neglect to reduce it. It may be associated or not with some venereal complication.

Treatment.—The object of the surgeon should be to reduce the glans behind the narrow prepuce by which it is strangulated, and, failing this by simple means, he must divide the constricting preputial orifice, so as to effect this end.

To carry out the first object an india-rubber band applied as an Esmarch's bandage will sometimes answer, but if it does not an anæsthetic should be given and the patient placed on his back; the surgeon should take the penis between the index and middle fingers of his two interlocked hands, and while thus pulling the prepuce forward forcibly press the glans backward with his two thumbs, the pressure of the thumbs and counter-pressure with traction of the interlocked fingers so displacing the fluid from the œdematous tissues as to allow of the reduction of the paraphimosis. When the œdema is very great, a few needle or lancet punctures facilitate the operation. When the affection has been of some days' standing and ulceration exists, and when failure has followed all attempts at reduction, the strictured preputial orifice must be divided; but the band must not be looked for directly behind the glans, but behind the roll of œdema-

Fig. 413.



Mode of Dividing Prepuce in Paraphimosis.

tous prepuce that surrounds it. This is best done by a cut half an inch long, made with a scalpel, in a vertical direction over the constriction, the thumb of the left hand forcibly depressing the glans penis (Fig. 413). The prepuce at times yields audibly and the wound gapes; the whole constricting medium should be divided. Some antiseptic lotion should be applied to the parts subsequently to assist recovery. After the paraphimosis has been reduced and the œdema subsided, it is wise in the case of children to circumcise, and in the adult the same practice is frequently desirable. In all cases of *œdema of the penis* in children the surgeon must remember that it may be due to mechanical strangulation.

Warty growths are very common on the penis, and they may be found fringing the orifice of the prepuce and the urethra or growing from any part of the mucous membrane between these two points; indeed, they may grow from within the urethra as well as from the outside skin of the prepuce. In the bulk of cases they have a venereal origin—that is, they have been caught by contagion, for warts are contagious—but they at times occur without any such cause in men who have long prepuces and who are not sufficiently careful in local cleanliness.

TREATMENT.—When they are numerous, their excision is the only successful treatment, nitrate of silver being applied to their bases; but in less severe examples the dry oxide of zinc, freshly powdered savine, and calomel are good local applications, the warts rapidly withering under their influence.

Cancer of the Penis.—In the middle-aged and old it is sometimes difficult, if not impossible, to distinguish simple warty from cancerous growths, although the greater obstinacy of the cancerous and their disposition to bleed are probably the best points of distinction.

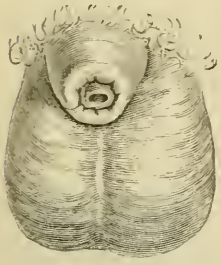
When there is ulceration, the disease is probably cancer. If the cancer be left to take its course, the glans penis and prepuce become infiltrated and the ulcer discharges a fetid ichorous secretion, breaks down, and spreads; the inguinal glands become involved, and death takes place from exhaustion. At times the whole organ is destroyed and the scrotum involved.

Cancer of the penis is generally of the epithelial variety, true carcinoma being comparatively rare.

TREATMENT.—In all clear cases of this disease, unless the inguinal or lumbar glands are extensively involved, amputation is the only sound practice to follow, and in the doubtful it is the wisest. When the prepuce alone is involved, the excision of the growth may be sufficient; but nothing less than amputation is of any use when the glans is affected. Under all circumstances the surgeon should cut quite free of the disease, for the tissues about it are probably more or less infiltrated with cancerous products. I have a patient alive and well now (1884) whose penis I cut off for cancer seventeen years ago, and a second from whom I excised a cancerous mass from the prepuce sixteen years ago.

Amputation of the Penis.—Since the galvanic cautery has been in use I have employed nothing else for amputation of the penis. A gum-elastic catheter should be introduced into the urethra and the platinum wire passed with a needle between the spongy and cavernous bodies, and then round the penis and made tight with the écraseur screw. Connection with the battery must then be made and the wire screwed *slowly* home; for if the tissues are divided too rapidly, hemorrhage will take place. The heat should not be too intense. The wire should then be made to divide in the same way the spongy body and the urethra, half an inch or more nearer the glans penis. Under ordinary circumstances the operation is absolutely bloodless and the subsequent pain slight. After the penis has been removed it is wise to slit the urethra open for about half an inch, turn its two edges outward, and fasten them to the skin with sutures. This step is good to prevent the contraction of the urethral orifice that may otherwise ensue. When the cautery is not to be had, the knife should be used. The old operation consisted in the removal of the organ by one clean sweep of the bistoury, an assistant having steadied and compressed the base of the organ by a band of tape. The modern improved operation—which, I believe, was suggested by Hilton—consists in the introdnction of a narrow bistoury between the spongy and cavernous bodies, and after dividing the latter the spongy body with the urethra must be cut through about half an inch more forward. The object of this is to make the urethra stand out from the stunted organ, and thus facilitate micturition. It is, without doubt, the best mode of

FIG. 414.



Stump of Penis after Operation.

amputating a penis with the knife. To prevent any tendency in the urethra to contract, it may be slit open or stitched back to the preputial skin. Fig. 414 illustrates the stump after such an amputation.

To arrest hemorrhage during the operation Clover's clamp for compressing the penis is very excellent, and ought to supersede the tape.

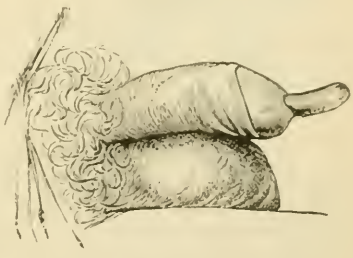
Other Tumors of the Prepuce.—The prepuce may be the seat of *fatty*, *sebaceous*, or even *fibrous*, tumors, though these are rare. It is not uncommonly the subject of what has been described as *elephantiasis*, although when the penis is involved the scrotum is usually similarly affected. I have, however, seen one case in a man aged thirty-five where the penis was thus alone affected. The organ was immense and frightful to look at. When in repose it measured eight inches round and six long. The man came to me with a gonorrhœa, admitting, however, that he had never been able to have true coitus since the disease had existed, which was about four or five years.

The disease is a chronic hypertrophy of the skin and cellular tissues. Nothing but the excision of the redundant integument is beneficial.

Injuries to Penis.

These are not common, excepting such minor injuries as laceration of the frænum or prepuce produced in coitus. Incised wounds, however, are occasionally met with, the products of insanity, jealousy, or malice; the parts require careful adaptation with sutures. Recently I had a man under care who was lifted off a bench by a woman holding his penis. The accident was followed by much urethral bleeding, which was stopped by ice, and a good recovery took place. The body of the penis at times, however becomes the seat of injury from some rough bending of the organ during connection or otherwise, and as a consequence, when the immediate effects of the injury have passed away, strange symptoms appear. Thus, some years ago I was consulted by a gentleman whose penis, when turgid, arched laterally, the cavernous body of one side having atrophied and become a mere gristly mass. This condition had followed an injury received in coitus many years before. Some great induration had existed for months in the cavernous body that had subsequently atrophied. More recently I have seen a married man about 60 who a year before "missed his mark" in coitus and hurt his penis; an induration followed, and at the present time, where this existed, there is a deficiency of tissue and when the penis becomes turgid it is never straight, but bent laterally.

Fig. 415.



Corpus Spongiosum projecting from Urethra after Injury.

A singular, case of injury to the penis was seen at Guy's in 1867, in the practice of Mr. Hilton. It was in a man æt. 50 who when nineteen had had his penis bitten by a stallion; after the accident some little bleeding occurred and a fleshy cylindrical body an inch and a quarter long and one-third of an inch in diameter projected from the urethral orifice. It was evidently the corpus spongiosum, which had been divided by the horse behind the glans penis and had become everted. When the patient was admitted, the corpus spongiosum urethræ terminated abruptly about one inch behind the glans penis and the urine flowed by the side of the protrusion (Fig. 415).

Malformation of the Urino-Genital Organs.

Malformations of the urino-genital organs are more common in the male than in the female subject, and show themselves in many degrees of severity. Thus when the upper surface of the urinary passage, from the orifice of the urethra to the fundus of the bladder, is deficient, a case of *extroversion of the bladder* or *ectopion vesicæ* is said to exist; when the urethra alone is deficient at its upper part, *epispadias* is the term employed. Some authors apply the latter also to the more complete condition. With this imperfect condition a separation of the pubic bones frequently exists, as well as some malformation of the scrotum, this sac being often bifid, though containing the testicles in proper position. At times a hernia complicates the case. When no testes are present and the scrotum is bifid, the question as to sex often arises; for in the female the vagina is frequently absent or so small as more nearly to represent a urethra than a vagina.

In **extroversion of the bladder** the posterior wall of the bladder appears as a red mucous mass below the umbilicus, which is lost in the upper border of the deformity. At the lower part of its surface the orifice of the ureters may be often seen as small nipple-like projections, and in some instances these orifices are lost in the pelvic chink, although they may be brought into view by depressing the fissured penis, or what represents the penis; for this will probably appear only as an expanded glans penis and a pendulous prepuce. The cleft urethra, as it becomes lost in the pelvic fissure, can be made visible by pulling the parts down (Fig. 416).

In the female subject the exposed urethra will be seen between the two labia. When the vagina is present, it will open at its upper border and appear continuous with the lower labia (Fig. 417). At times, though very rarely, the epispadias involves only the urethra.

Fig. 416.

Ectopion Vesicæ in Male.

Fig. 417.

Ectopion Vesicæ in Female.

I have seen but a few cases of this peculiarity, and in all the exposed mucous surface of the urethra passed backward toward the pubes into a fissure, which was covered in by a thin transverse fold of skin, from beneath which urine flowed. The scrotum was large, but bifid, and contained the testes (*Guy's Hosp. Rep.*, 1868).

Treatment.—The chief annoyance connected with this deformity being due to the constant dribbling of the urine, Messrs. Simon and Lloyd were induced to carry out an ingenious operation by which the urine might be carried into the rectum and the fissure subsequently closed, but the attempt failed and has not been repeated. For particulars the reader may refer to the *Lancet* (1851 and 1852). Holmes has suggested a modification of Simon's plan, and it is probably in this direction that some good may eventually be found.

In a case of epispadias in a boy recently under my care (September, 1875), in which the whole of the urethra down to the neck of the bladder was fissured, and in which, consequently, there was incontinence of urine, I tapped the urethra in the perinæum in front of the prostate and established an artificial urethral opening. By these means the urine passed through the perinæum instead of above the pubes, and consequently could be caught and retained in a urinal, greatly to the patient's comfort. In another case—one of a boy æt. 7—I in May, 1880, after making a perineal incision, drew down the penis, brought it out of the perineal wound, and fixed it there. Subsequently I completely closed the original fissure below the pubes. The case did well, and all the urine flowed through the perinæum and was readily caught in a urinal.

Other surgeons, however, have devised means by which the exposed mucous covering of the bladder may be covered in, thereby adding to the comfort of the patient, and of these Wood of King's College has been the most successful. He has operated in ten such cases, and Holmes in five. I have operated only in two. Four of Wood's succeeded completely, three of Holmes's, and one of mine, the others being partially successful. The operation consists in bringing up flaps of skin from either side of the fissure and covering it in, fastening them together by sutures. (For full details *vide Med.-Chir. Trans.*, vol. lii., and Holmes's *Surg. Dis. of Child.*, 1868.) In one case I destroyed the mucous membrane with the cautery, and thus turned it into a cicatrix, avoiding the ureters.

Hypospadias is a term applied to any deficiency of the under surface of the urethra, and in the larger number of cases the urethral orifice is placed below the glans at a spot corresponding to the preputial frænum. In some a depression exists in the glans penis corresponding to the natural outlet, with several small depressions between

the urethral orifice and the cuplike depression at the extremity of the glans, while in others one or more foramina are present, situated below the true opening of the urethra, through which urine escapes. The urethral opening in these cases is often small and requires enlarging.

In more extreme cases the urethral orifice appears at the base of the penis, when the deformity is commonly associated with a bifid scrotum; under these circumstances, when the testes are absent, the question of sex is raised. In a case of this kind which I saw in 1867 the sexual passion was so strong that a man came to me to ask for castration, as he was unable to copulate on account of the stunted condition of his penis, and the way in which it was held down by a band which caused it to arch downward under excitement. The man at the time had testitis from ungratified passion.

TREATMENT.—The operative measures that have been employed for the relief of this deformity have hitherto not been very successful, although recently (*Med. Times and Gaz.*, January 30, 1875) Mr. John Wood has recorded two cases of the *balanic* or *penile* varieties in which relief was given, and M. Duplay has published (Paris, 1874) full details of his method of dealing with the more advanced form of malformation, called the perineo-scrotal (Fig. 418, A). I think so well of Duplay's operation that I will describe it. It has for its object, *first*, to separate the penis from the scrotum and destroy its arching, in order to allow erection and coition; and, *secondly*, to construct a new urethra from the abnormal perineal opening to the glans penis.

FIG. 418.

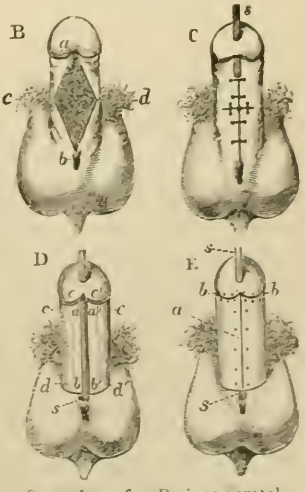
A
Perineo-scrotal Hypospadias.

To carry out the first indication, a free division of the fibrous bands connecting the penis with the scrotum has to be made; and when this can be effected by a subcutaneous wound, as adopted by Bouisson, so much the better. Duplay, however, incises transversely the tissues from without inward, dividing, if necessary, the envelopes and septum of the corpora cavernosa; this incision leaves a lozenge-shaped wound (Fig. 419, B), the edges of which may be brought together by sutures (Fig. 419, C). After this operation the penis is to be kept constantly stretched, to guard against subsequent retraction, and six months later the second part of the operation should be carred out.

The construction of a new urethra is a difficult matter, and must be carried out in stages. Duplay's method is divided into three: 1st, the restoration of the urinary meatus; 2d, the creation of the new urethra from the meatus down to the hypospadic perineal opening; and 3d, the reunion of the two portions of the urethra.

The *first stage* may be done at the same time as the correction of the arching of the penis, and consists in simply paring the edges of the glans penis and bringing them together by sutures round a catheter (Fig. 419, C). It is almost always successful.

FIG. 419.



Operations for Perineo-scrotal Hypospadias.

The *second stage* is to be effected in the following manner:

The penis being held up, two longitudinal incisions are made on its inferior surface parallel to the median line and extending from the glans penis to the perineal urethral opening, these incisions being bounded by two transverse ones (Fig. 419, D). Two quadrilateral flaps are thus formed (*a b, a' b'*), which should be large enough, when turned back, to cover a catheter that has been previously introduced into the urethra.

The cutaneous surface of these flaps should next be turned toward the catheter and the raw surface exposed to view.

The skin of the penis, in continuation of the transverse incisions, is then by a little dissection made to furnish two new flaps (*c d, c' d'*) for covering the raw exposed surface of the first flaps.

Lastly, the lower edge of the glans penis is vivified in the part which corresponds to the new channel.

The flaps must now be united, their superior edges being stitched to the vivified glans, and the two flaps on each side of the urethra, the superficial and deep, brought together with metallic or other sutures (Fig. 419, E).

The *third* stage of the operation consists in the reunion of the two portions of urethra, and should be effected by paring the edges of the hypospadic orifice and bringing them together by sutures, deep and superficial.

After the operation the urine must be drawn off by means of a catheter, and the union of the parts is usually completed after three or four days. To render this result more certain the membranous portion of the urethra might be opened in the perinæum, as in cystotomy or median lithotomy, and a catheter introduced into the bladder to divert the urine from the seat of operation during the healing process.

Puberty is the best period, probably, for the performance of this operation.

Occlusion of the urethra from some membrane or band sometimes exists, which if not broken down in intra-uterine life leads to dilatation of the bladder, sacculation of the ureters, distension of the pelvis of the kidney, and destruction of its secreting structure. (*Vide* cases by Morris, *Med.-Chir. Trans.*, 1876.)

ON LOCAL VENEREAL DISEASE.

Gonorrhœa.

Urethritis, gonorrhœa, and **clap** are terms applied to cases of inflammation of the urethra of every degree of intensity and the product of a great variety of causes. In some the affection is the consequence of the direct irritation of an instrument passed into or left in the urethra, while in others it follows excessive or ordinary sexual intercourse with unchaste women or with chaste women who are out of health and suffering from acridity of the vaginal secretion. "A leucorrhœa," writes Diday, "which would have remained inoffensive after a single coitus, takes on, by redoubled excitement, irritant properties, and furnishes then a contagious fluid" (gonorrhœa). It is the direct product, most commonly, of contagion from the pus of an inflamed mucous membrane. Simon (*Holmes's System*, vol. i.) having shown that "there is ample room to question the popular impression that only specific inflammations are communicable; much reason for suspecting it, on the contrary, to be a generic and essential property of inflammation that its actions are always in their kind, to some extent, contagious, pus from an acute inflammation producing its kind on inoculation."

Lee states (*Holmes's System*, vol. iii. ed. 3) the causes of urethritis to be the application of a gonorrhœal discharge to the sexual organs, and also certain irritating substances applied to the mucous membranes, such as menstrual fluid, leucorrhœal discharges, and the injection of a solution of ammonia; he does not exclude constitutional cause, such as gout or rheumatism.

It is well to bear in mind also Ricord's observation, "that gonorrhœa often arises from intercourse with women who themselves have not the disease;" and Diday's, "that from the very fact of a woman having a discharge, no matter what its origin, she is liable to give a discharge to a man." Complaints closely resembling gonorrhœa sometimes appear in persons the subjects of stricture after sexual intercourse, a debauch, or other excitement.

The disease may be *acute* and come on within a few hours of connection, or it may fail to show itself for five or ten days; and, in a general way, the sooner the symptoms appear after the contagion, the acuter the disease. It may be *subacute* or *chronic*.

Symptoms.—It generally commences by an itching about the orifice of the urethra, the mucous membrane of which will probably appear swollen and injected; there will be the sensation of heat on micturition, and after the lapse of a few hours some muco-purulent fluid will be squeezed out of the urethra. In acute diseases the urethral discharge will soon become abundant, and yellow, green, or blood-stained pus will flow from a highly-injected and swollen urethra; the whole glans and penis will become red, swollen, and painful; micturition will also probably be difficult, painful, and scalding, the passage being obstructed by the swelling of the mucous membrane. Chordee, or painful erections, as the disease advances, will appear, and later on perineal pain, if not suppuration. The groins, testicles, and perinæum, too, become the seat of more or less tenderness, and constitutional symptoms show themselves, varying with the degree of the inflammatory action; in some subjects the febrile condition is well marked, but in most it is absent. After the lapse of ten or fourteen days these acute symptoms partially subside, the discharge becomes thinner and more muco-purulent, the external signs of inflammation less marked, the pain on micturition less severe; the perineal, inguinal, or scrotal pain probably will have disappeared, a thin muco-purulent urethral discharge, with a slight sensation of heat on micturition, alone remaining.

When these symptoms are allowed unchecked to run their course, they will gradually pass into the condition known as that of *gleet*, in which a thin muco-purulent urethral discharge exists, unattended by any local or general source of pain. *Gleet*, however, may be the result of some stricture or local urethral disease, such as an ulcer.

The ordinary seat of the affection is the mucous membrane of the urethra, the orifices of the lacunæ being chiefly involved. The fossa navicularis and parts around and the mucous membrane of the bulb are the most common seats, the dissections of Sir A. Cooper, Ricord, Thompson, and others having proved this. At times, however, gonorrhœal inflammation may, as Wallace pointed out (*On Venereal Disease*), involve at the same time the whole of the urethra, the bladder, the testicles, the glans, and the prepuce in the male, and in the female the nymphæ, clitoris, vagina, etc., the disease, as it creeps along to the posterior part of the urinary passage, decreasing in intensity in the anterior. In severe cases the inflammation may extend to the submucous tissue and run on to thickening, and even to suppuration.

Urethritis the result of some mechanical irritation of the urethra is rarely acute; as a rule it subsides as soon as the cause has been removed, Urethritis the consequence of some gonorrhœal contagion is almost always acute, and, having once been started, is not readily arrested.

Gleet, whether the consequence of an acute or of a subacute inflammation, when of some standing, is almost always due to some urethral contraction or stricture.

Gonorrhœa in the Female.—In the female gonorrhœa is to be recognized as a yellow purulent vaginal discharge accompanied by heat, pain, and signs of acute inflammation. The less purulent it is, and the more the discharge is made up of mucus and epithelium scales, the greater is the probability of the disease being due to vaginal irritation other than gonorrhœal—that is, to leucorrhœa; and when the discharge is made up of masses of glutinous, semi-transparent, albuminoid material like the white of egg, the more certain is it that the discharge is uterine and comes from the glands in the neck of the uterus.

It must be remembered, however, that in both sexes, as long as any purulent or semi-purulent fluid is poured out by the mucous membrane of the genital passage (even the slightest gleet), violent urethritis or inflammation of the vagina may arise in another subject by contagion, and there is good reason to believe that sexual excitement is an important element in aiding the propagation by contagion. Mr. J. Morgan of Dublin believes that the vaginal discharges of constitutionally infected women are the cause of the majority of sores in men.

Treatment.—Gonorrhœa or urethritis is a local disease and may be treated locally with success. When it is the result of local irritation from the passage of an instrument, no treatment is called for, the discharge ceasing naturally as soon as its cause has been removed; but when from gonorrhœal contagion, such a result is not met with.

In a very acute clap, when the urethra and penis are swollen from vascular turgescence, free purgation with salines is the best practice, and in plethoric patients the addition of antimony in quarter-grain doses, to excite nausea, is most valuable.

In less severe cases copaiba may be given in doses of twenty drops or half a drachm three times a day with advantage, but this drug should not be continued for more than three days. If it is to do good, it will show its influence within that time, and a longer continuance of the drug is useless and deleterious. The yellow oil of sandalwood may also be employed in the same dose and under like circumstances, and at times it acts most beneficially even when the copaiba has failed, but it is in no way certain in its action.

For cleansing purposes an injection containing three or four drops of Condy's fluid to the ounce of water is to be advocated. It may be used in all stages of the disease. Astringent injections are always of value when they can be used frequently and efficiently, but strong injections are to be condemned. They may cure the disease suddenly, but more commonly they fail and set up inflammation of the bladder and other mischief by adding to the irritation.

The best injection in all stages of the disease is tannin in the proportion of three to six grains to the ounce, and next to this is alum in the proportion of two or three grains to the ounce, or the chloride of zinc one grain to the ounce. A solution of salicylic acid is also good, half a drachm of the acid being dissolved in six ounces of water with a scruple of borax. The perchloride of mercury, one grain to six ounces of distilled water, as an occasional injection, has been recently advised. To be of use injections should be used from four to six times in the twenty-four hours. An ordinary glass syringe will answer every purpose if the glans penis be well held, but there are special syringes which are

supposed to have some advantages. During this treatment the use of such alkalies as the citrate or tartrate of potash in twenty-grain doses, or ten grains of the bicarbonate, may be given and good food allowed, but little or no stimulant.

In the chronic stage I have found great benefit from the introduction into the urethra of a large catheter covered with the glycerine of tannic acid, and at times the suppositorium acidi tannici rolled into sticks and passed into the urethra acts most beneficially.

The best way to give copaiba is as a bolus mixed with calcined magnesia and wrapped in wafer paper, or as a mixture with gum and peppermint water. The capsules are uncertain in their action. Copaiba is well known to produce in some patients a severe rose urticarious eruption. Cubebs are less to be relied on than is copaiba.

In using injections the object is to make an impression upon the mucous membrane by their astringent effects, and to keep it up. Weak astringents frequently employed are far more valuable than strong ones used at longer intervals. When so used, they are as beneficial in gonorrhœal inflammations of the urethra as in that of the eye. When a man can devote himself to the cure of his clap and throw into his urethra a weak astringent every hour, he will often check it within two or three days, in the same way as a gonorrhœal inflammation of the eye may be controlled under similar treatment. The nitrate of silver injection is an uncertain, and at times a dangerous, remedy, often adding to the disease instead of diminishing it. In all cases of long-continued clap or gleet in the male the presence of a stricture should be suspected. It may often be made out by the passage of a full-sized *bougie à boule* when an ordinary catheter fails to detect it. The gleet should only be satisfactorily treated by the cure of the stricture—that is, its full dilatation.

Tonics, particularly iron, are valuable adjuncts to the treatment.

All connection must be forbidden for some time after the apparent cure of a clap, for any sexual excitement is likely to be followed by a relapse. Drinking and smoking to excess are injurious.

In women a clap is readily cured by the frequent use of astringent injections of tannin, alum, or sulphate of zinc ʒss to a pint; the passage into the upper part of the vagina of the tannic acid suppository is also excellent treatment. In the use of both these means the patient should lie down with her hips raised, and the astringent should be allowed to remain in the passage. To inject it sitting or standing is a useless, although a too common, practice.

Complications.

In male subjects **inflammation of the epididymis** is the most common complication, the disease doubtless spreading in a direct way from the urethra through the vas deferens and cord to the epididymis. In some cases it stops at the cord; in others, it goes on to affect the testicle itself. It is often associated with hydrocele, and from this fact some surgeons have been led to believe that inflammation of the testicle itself is a common consequence of a clap. The treatment of this affection will be considered in a future page.

In the female **inflammation of the ovary** is said to occur, and even **pelvic peritonitis.**

Abscesses in the cellular tissue external to the urethra, penile or perineal, are often met with in acute gonorrhœa, and should be opened early.

Chordee, or painful erection caused by the stretching of the corpora cavernosa, into which inflammatory products have been infiltrated, is a common consequence, and a very painful one. Full doses of opium (gr. j) or ten grains of henbane, and a like dose of camphor, are reliable remedies. Ricord used a suppository of ten grains of camphor and one grain of the extract of opium; I have sometimes thought the morphia suppository the most useful. Belladonna smeared over the urethra also gives relief at times.

Retention of urine may likewise occur from the mechanical closure of the urethra through its swelling, from spasm of the urethra, or from both causes. The warm bath and opium are the best remedies for the complication, a catheter being passed only when an absolute necessity exists.

Inflammation of the prostate is likewise a complication, as is also **inflammation of the bladder.** (*Vide* Chapter XXI.)

Inflammation of the inguinal glands, or **sympathetic bubo,** is often present, the glands occupying the upper part of the groin being usually involved, but those below Poupart's ligament are not seldom affected. In neglected cases these glands

may suppurate. Fomentations and tonics are the necessary treatment. The absorbents of the penis are at times inflamed and suppurate.

Balanitis.—When the glans penis and prepuce are involved in the inflammation and this inflammation is attended with profuse discharge, *balanitis* or *external gonorrhœa* is said to be present. This affection may be due to want of cleanliness as much as to gonorrhœal contact. When the prepuce becomes œdematous and is long, *phimosis* takes place; when narrow and retracted behind the glands, so as to be irreducible, *paraphimosis* exists.

Treatment.—This balanitis should be treated locally by astringents, such as the acetate of lead or the nitrate of silver lotion v–vj grs. to the ounce, painted on the inflamed part. Phimosis and paraphimosis should be treated on principles already stated.

It should be remembered, too, that a balanitis associated with a rawness or erosion of the glans or prepuce may be due to a syphilitic inoculation.

Warts.—As a consequence of balanitis *warts* are very common, and may cover the mucous membrane of the glans and prepuce or invade the urethra itself. They may grow to a great size, putting on much the appearance of a cancerous penis. I have seen them perforate the prepuce of a penis when phimosis was present.

Treatment.—They can be treated only by removal. When extensive, their excision is the best plan, the operation being performed with the patient anæsthetized, nitrate of silver or perchloride of iron or the galvanic cautery being freely applied to the base of the warty growths. In less severe cases the warts will often wither if kept dry with the oxide of zinc or the fresh powder of savin.

All warts are not, however, gonorrhœal; some may arise without any such cause, even in clean subjects. They are nevertheless contagious. In women they are often found up the vagina, but more frequently at its orifice.

Gonorrhœal Rheumatism.—An affection so called is an undoubted complication of the disease, explain it as we may. At the end of an attack of clap, patients, without doubt, are often attacked with severe pain and tenderness of one or more joints, attended with effusion and constitutional disturbance. It may occur with every fresh attack of clap, and I have recorded a case in my book on the joints in which it recurred sixteen times after sixteen different attacks of gonorrhœa. Some authors look upon this affection as a species of pyæmia due to the absorption of some morbid matter from the inflamed urethra, but evidence is still wanting to prove the truth of the theory. It rarely appears during the acute stage of the affection, mostly in the chronic, but arrest of the discharge cannot be associated with its appearance. The knees and ankles are the joints mostly involved, yet those of the upper extremities are so at times. The fair-haired and what are called strumous subjects are said to be more prone to the disease, but I cannot say I have observed this. At times the rheumatic pains are more confined to the tendons, fasciæ, and muscles; the heels and soles of the feet are also frequent seats; as a result of this inflammation the parts involved, and particularly the fascia, may soften and yield. The late Dr. Babbington used to say that this form of fascial rheumatism was found only in those who had taken copaiba.

The disease may be *acute*, *subacute*, or *chronic*; and when acute, it may run on rapidly to suppuration. The most acute example of suppuration of a knee-joint I have seen was of this nature; it occurred in a man æt. 35 during the acute stage of gonorrhœa. It was treated by free incisions into the joint, and followed by a good recovery with a stiff joint. This may well be called acute *gonorrhœal synovitis*, to distinguish it from an acute *gonorrhœal arthritis*, upon which my friend and colleague Mr. Davies-Colley has written an able paper (*Guy's Hosp. Rep.*, vol. xli., 1883, p. 187). Gonorrhœal arthritis "is as often found in the female as the male—perhaps more often. It usually begins before the gonorrhœa or discharge has existed for any considerable time, and the subjects are generally under the middle age. The onset is like that of an attack of acute rheumatism. The patient is feverish and has pain, tenderness, and swelling of several joints. These symptoms are often so severe that he has to take to his bed. In a few days the inflammation leaves all the joints save one, in which it concentrates itself with great severity. This may be any one of the larger joints. Most frequently I have seen it in the elbow. The appearance of the joint is not at all like that which is seen in acute synovitis. There may be effusion within the synovial sac, but the most striking characteristic is the œdema of the soft parts round the joint, accompanied, as a rule, during the height of the attack, by redness of the skin. The swelling is in some cases very great; and when the elbow has been affected, I have seen the redness and œdema extending from the shoulder to the wrist-joint. I believe that the superficial effusion is due to the inflammation having attacked especially the

fibrous tissues of the capsule rather than the synovial membrane by which it is lined. The slight amount of effusion which occurs in the synovial sac is probably secondary to the affection of the adjacent fibrous tissues, just as we sometimes see an acute periostitis near the end of the diaphysis of a long bone accompanied by some effusion into the neighboring articulation. The joint is very tender, hot, and full of pain, and any attempt to move it gives rise to excruciating pangs. The general temperature of the body is but little elevated." From the great œdema which accompanies this affection it may be mistaken for phlegmonous erysipelas, phlebitis, or lymphangitis, but a little care should prevent an error in diagnosis from being made. Mr. Davies-Colley has pointed out that it may be associated with cardiac complications.

Treatment.—Medicines seem to have but little influence on this disease. Local treatment is, however, very necessary, such as immobility of the affected joint, with warm fomentations, with or without the decoction of poppy-heads. The extract of belladonna or opium diluted with vaseline is at times a valuable application. Opiates to relieve pain are essential.

Should the joint suppurate, it must be dealt with by free incisions. In the arthritic form this result is rare. When the acute symptoms have subsided, pressure is of great value.

Under all circumstances the urethral or vaginal discharge must be cured. Passive movement of the joint must be resorted to as soon as swelling and heat have gone, but many joints become permanently stiff after this affection.

Messrs. Duplay and Brun, who have written on the subject (*Archives Générales de Médecine*, 1881), advocate the use of plaster of Paris splints.

Herpes Preputialis.—This is a simple affection which may be mistaken for chancre, and is known by the appearance of a crop of vesicles around the corona of the glans or upon the external or internal surface of the prepuce. It is generally attended by much local irritation and local evidence of inflammation, the vesicles when they burst often discharging freely. The affection runs its course in a few days, and then the parts heal. A zinc lotion of three or four grains to the ounce, or a solution of nitrate of silver gr. v to the ounce, expedites recovery.

The number of vesicles and their grouping is generally sufficient to enable the surgeon to diagnose this affection from a venereal disease.

Chancre

may be defined as a sore the result of venereal contact, and in a general way it is found upon the penis of the male and the genitals of the female, but it may be seen upon other parts of the body, such as the pubes, thighs, lips, tongue, nipples, fingers, etc.—in fact, wherever the secretion from an infected subject may be applied to a raw surface.

In by far the larger number of cases this disease begins and ends as a local affection; in a smaller number it is a local inoculation of a constitutional disease and is followed by syphilis. The sore is not syphilis, although it is the direct means of communicating syphilis, any more than the inoculation of smallpox is smallpox, although the inoculation may be the means of giving smallpox.

So long as the chancre is a local affection alone it is comparatively unimportant, however extensive and troublesome it may be in healing; but whenever it is the local inoculation of a constitutional affection such as syphilis, it is of grave importance, however apparently trivial may be the local sore.

It becomes, therefore, a vital question to make out from the appearances and conditions of the sore whether it is likely to prove a local disease only or to be followed by constitutional symptoms, and to a certain extent this diagnosis may be made—that is, a surgeon may from the external appearance of a chancre go so far as to say that in all probability *this* one will not be followed by syphilis and *that* one will, but he can do no more; to dogmatize upon the point and to speak with certainty are beyond his power.

The chancre which will not in all probability be followed by syphilis is the *soft suppurating sore;* the chancre that will in all probability be followed by syphilis is the *hard non-suppurating sore.*

John Hunter thus described the indurated chancre: "The sore is somewhat of a circular form, excavated, without granulations, with matter adhering to the surface, and with a thickened edge and base. The hardness and thickening are very circumscribed, not diffusing themselves gradually and imperceptibly into the surrounding parts, but terminating abruptly." In this description we read the type of the hard infecting chancre—the chancre

of the inoculation of syphilis, wherever found. Hunter adds, however, that "a chancre has commonly a thickened base; and although the common inflammation spreads much further, yet the specific inflammation is confined to this base." An infecting chancre may, too, appear only as a crack, excoriation, or indurated tubercle, without abrasion.

This form of chancre is commonly associated with some induration, not suppuration, of the first row of the inguinal glands—the *multiple indolent bubo*. Its secretion consists of epithelial *débris*, of globules of lymph more or less perfectly formed or disintegrating, and of serum, *not pus*, and not auto-inoculable. In debilitated and unhealthy subjects, adds Lee, infecting sores will suppurate as any non-specific lesion would do, and in such cases it is sometimes very difficult to distinguish the secretion produced by the local disease from that which depends upon constitutional peculiarity.

The *soft suppurating chancre* is often multiple and has an excavated surface with neatly shaped and cut edges, as if the wound had been punched out. It has an irregular and worm-eaten surface secreting abundance of pus. It is prone to spread rapidly and to become phagedænic. It has usually a soft base; but if otherwise, it will have what Ricord has described as a phlegmonous hardness, and not a defined one, as in the syphilitic chancre. It is commonly associated with a suppurating bubo, and secretes pus which "has the property of always reproducing its specific action when applied to another part of the same body or when inoculated upon another person" (H. Lee).

The experiments of Fournier and Rollet and Lee's observations led the latter surgeon to "conclude that if a venereal sore yields a secretion capable of being inoculated so as to produce the specific pustule, the evidence, so far as it goes, is in favor of its being a local disease and of its not requiring constitutional treatment. If, on the contrary, a disease which we believe to be primary syphilis yields a secretion which is not auto-inoculable, then the evidence is against the local character of the affection and indicates a constitutional mode of treatment." In this we read the type of the simple local venereal sore.

In a clinical point of view, however, this great distinction between the two forms of chancre is not always definable; and consequently an intermediate class of cases in which syphilis occurs has to be recognized, in their clinical features more approaching the soft sore.

There are, therefore, three forms of syphilitic sore, which the government committee on syphilis has thus well described: One characterized by induration throughout its entire course; one soft in its early stage and becoming subsequently indurated; and one soft throughout the whole course, but which, unlike the simple local sore, is followed by constitutional disease.

Hard sores do not of necessity give rise to syphilis, whilst soft sores may. And it is an undoubted fact that the question of induration or non-induration is greatly determined by the position of the sore, chancres on the female genitals simple or syphilitic, and chancres on the glans penis being rarely hard.

The point, therefore, resolves itself into this—that the indurated chancre with a fair amount of probability, although not certainty, may be the precursor of syphilis, and not a merely local disease. The soft or non-indurated sore, in exceptional cases, may be due to a syphilitic inoculation, although in the majority of cases it is a purely local affection.

A crop of soft sores fringing the prepuce or surrounding the corona is, in all probability, a simple and non-syphilitic disease.

A spreading chancre with a suppurating bubo is probably a local affection.

A small single chancre indurated from the beginning is the most suspicious of syphilis, although even in this there is no certainty of its being so. In fact, it is not possible to speak with any certainty as to a chancre being syphilitic or otherwise. Syphilis is a constitutional disease which can be recognized only by its constitutional symptoms, and not by the point of its inoculation.

With respect to the *period of incubation* of a simple or syphilitic chancre no definite time can be given, since it varies from a few hours to a week, but the multiple suppurating simple chancres, as a rule, appear more rapidly after infection than any other; the syphilitic chancre often does not appear for a week at least, sometimes two or three, after infection. Dr. Bumstead of New York says that "an interval of at least ten days will be found to have existed between infection and the appearance of the sore" (edition of *Cullerier's Atlas of Venereal Disease*, 1868).

A chancre, like any ordinary sore, may present different appearances at different times. It may be at its origin vesicular, papular, pustular, or an excoriation, and pass

through the *ulcerating*, *granulating*, and *cicatrizing* stages; in one case the ulcerating stage will be a long one, while in another it may be so brief as hardly to be recognized.

The action of the sore may vary with the condition of the patient, as well as with the condition of the part upon which it is placed; and it will probably be influenced by the nature or the stage of the infecting sore from which the disease has been communicated.

A chancre, like an ordinary sore, when there is much local action and little constitutional power, may become irritable, inflamed, or phagedænic, more particularly when drink, irregular living, and debauchery have so enervated the system as to render the patient unable to withstand the effects of any local irritation. These various actions may attack the chancre at any period of its progress.

When a chancre is sloughing or phagedænic from the first and has originated from an inoculation of syphilitic matter, there is every reason to believe that the sloughing process may have a beneficial tendency, since the very intensity of the local effects of the poison may be the means of preventing its absorption, and thus, also, the outbreak of syphilis. When, however, the sloughing action appears during the ulcerating or later period of the chancre's progress, it will have no such useful influence: for when syphilis is inoculated through a chancre, it is during its vesicular, papular, or pustular condition, prior to its ulcerative stage, and no action of the sore that appears after this period can have any effect in checking the diffusion of the poison. "If the inflammation spreads fast," writes Hunter, "it shows a constitution more than naturally disposed to inflammation; if the pain is great, it shows a great disposition to irritation; it also sometimes happens that they very early begin to form sloughs. When this is the case, they have a strong tendency to mortification." "These three conditions of a sore," adds Aston Key, commenting upon the above, "distinct in their cause and in their operation from the syphilitic action, are adverted to as pointing out the distinction that is to be drawn between the irritable, inflamed, and the sloughing chancre, and afford a guide to the pathological surgeon as safe and as intelligible as the more elaborate descriptions of modern writers" (*Guy's Hosp. Rep.*, 1840).

Treatment.—The uncertainty that most surgeons entertain as to the nature of a chancre, from the knowledge that any sore upon the penis, ranging from a simple excoriation to an indurated chancre, may be the inoculation of syphilis, renders it desirable and expedient that all sores should be destroyed at the very earliest period; and when this is effectually done before the ulcerative stage has set in, or during the vesicular, papular, or pustular stages, there is good reason to believe that constitutional syphilis may often be prevented.

When, however, the sore exists as an ulcer, this abortive practice is useless: indeed, in the majority of cases it makes a small sore large, retards recovery, and in no way prevents syphilitic symptoms appearing if the chancre had had a syphilitic origin. But, taking all together, not one chancre out of four has a syphilitic origin.

For the destruction of a chancre on its first appearance, nitrate of silver, nitric acid, potassa fusa, or chloride of zinc may be applied, so that the base of the sore is well destroyed.

When this is not done, the chancre should be treated on ordinary principles: to the inflamed sore, lead lotion, with or without opium, may be applied; to the sloughing sore, opium with tonics, internally, is indicated; to the indolent sore, nitric acid lotion or black wash is the best stimulant: while to ordinary sores, iodoform should be used.

A chancre requires no special treatment beyond its primary destruction from motives of expediency or with the hope of preventing constitutional infection. The common practice of applying black wash to all sores on the penis is not needed, and to cauterize all chancres at every stage of their existence as soon as they come under notice is unnecessary. When the powers of the patient are feeble, tonics are called for, and any special conditions are to be treated on common principles.

Medicines useful for syphilis should be given only when other evidence of syphilis exists beyond that afforded by the local inoculation. To treat all chancres alike, as if due to syphilis, is uncalled for and unscientific; by doing so many patients are materially injured.

Complications.

Phimosis is one of the most common complications, and is found in at least a fourth of all forms of chancre and at all stages of their progress. It is probably most frequent with the sloughing sore. In the fringing preputial chancres, however, it is a common complication. It is an accidental accompaniment of a chancre, and is due to the inflam-

matory infiltration of the prepuce. When not severe, it is not a condition of much importance if local cleanliness be attended to, for as the chancres heal the inflammatory œdema will subside and the parts will assume their natural condition.

When, however, *œdema is present* and a blood-stained discharge mixed with the *débris* of broken-up tissues escapes from beneath the prepuce, and doubt, consequently, is felt as to the nature, position, and character of the chancre; when evidence exists that the parts beneath are undergoing a destructive process which demands direct local treatment,—the prepuce must be slit up, the surgeon taking care to do this effectually, since through a want of due attention to this point the glans penis may be destroyed or the prepuce perforated. When the sore has been exposed, it ought to be treated on ordinary principles. When a simple purulent discharge comes from the orifice of the prepuce, the constant use of water and simple lead or other injection will probably suffice. Phimosis without inflammatory œdema rarely calls for treatment.

Phagedæna.—Venereal like other sores may slough, the suppurating chancre being more prone to take on this action than the non-suppurating and indurated. When a sore sloughs from the first, it will probably prove to be non-infecting; and even if syphilitic in its origin, it may lose its syphilitic nature, the sore, when the sloughing action has ceased, becoming a simple one. This action is at times so intense that the penis rapidly swells, inflames, and becomes gangrenous after infection, the whole organ at times sloughing off, while at others the action will be more partial.

In exceptional instances the mortification is of the dry kind. In the Peninsular war, when the British troops were in Portugal, this sloughing of the penis from inflammation was so severe that Inspector Fergusson (*Med.-Chir. Trans.*, vol. iv.) wrote: "It is probable more men have sustained the most melancholy of all mutilations during the four years at war in Portugal through this disease—which was called the 'black lion'—than the registers of all the hospitals in England could produce in the last century." He attributed the severity of this affection to the free sexual intercourse of persons of different nations.

How far this phagedæna depends upon some peculiar power of the infecting poison or upon the constitution of the individual patient is difficult to determine, although the latter probably has the greater influence, since, when any such depressing agency as that caused by drink, excess of venery, or illness is present, phagedæna is more likely to occur than under other circumstances.

Treatment.—In the treatment of all cases of phagedæna, opium, tonics, and good living are the three essentials, while mercury and the iodide of potassium are inadmissible.

Locally, the part must be kept clean by frequent ablution, and to this end the prepuce often requires to be slit up. Lotions of nitric acid one drachm to five ounces of water, of carbolic acid one part to thirty, of sulphate of copper five or ten grains to the ounce, of potassio-tartrate of iron from ten to twenty grains to the ounce, are also useful, and opium in solution is often a good addition. When the disease spreads, local mercurial fumigation is said to be of value, but change of air is most beneficial.

Adenopathy, or **bubo,** is a common complication of the simple as well as of the infecting chancre—that is, it is found in the local venereal sore as well as in the inoculation of true syphilis, but in the former the gland, as a rule, suppurates, while in the latter it rarely does so—at any rate, as a consequence of the local sore.

"Lymphatic absorption," writes Lee, "from a suppurating syphilitic sore (simple) necessarily produces a suppurating bubo; any attempt to prevent such an affection from suppurating is entirely futile. The disease within the lymphatic system is the same and runs a similar course as that upon the surface of the body."

The bubo associated with the simple non-infecting sore is the direct result of the absorption of the specific pus, the matter in the interior of the gland retaining its specific characters, whilst that outside the gland is ordinary non-specific pus. As the disease advances, however, the two fluids mix, and the whole acquires the characters of the specific fluid, the surface of the sore about the glands becoming in this way inoculated.

In the infecting and syphilitic chancre the enlargement of the glands is usually indolent and unconnected with suppuration. It appears within the first or second week of the inoculation, and many glands are usually involved, forming hard, indolent, painless swellings. In exceptional cases, however, where the sore is a source of local irritation, suppuration of the glands may take place, the suppurating bubo in the course of the constitutional symptoms being no rare event. The presence or absence of suppuration in the inguinal glands is not, therefore, evidence of any positive value as to the existence or

non-existence of a syphilitic affection. It may, however, be stated that a local sore on the penis associated with an adenopathy which passes rapidly on to suppuration is in all probability a local, and not a syphilitic, affection, while a local sore with a simple induration of the glands is in all probability a syphilitic inoculation.

In every form, therefore, of chancre, though more frequently in the local sore, simple adenitis or sympathetic bubo may be met with as a result of local irritation which differs in no respect from the adenitis of any other local organ. One or more glands may be involved in the action, and suppuration may be acute, subacute, or chronic. In the simple local sore it is usually acute. As a rule, too, the sore formed by the venereal bubo, unlike that resulting from simple adenitis, instead of healing kindly, often takes on very much the appearance of the local disease: the edges ulcerate, the opening enlarges, and a large sore is formed; indeed, from this action the *serpiginous* sore, to which allusion will be made, often takes its origin. At times the bubo puts on a phagedænic action and spreads fearfully.

In rare cases the glands are said to enlarge without any local lesion, this chronic enlargement being followed by syphilis. I have, however, never seen a marked instance of this, and in reputed cases have suspected the former existence of some overlooked local sore or fissure. Mr. Cock does not recognize the affection.

Treatment.—There is nothing to be gained by suppuration of the inguinal glands, for, even when associated with syphilis, the poison is not eliminated by such means, and when due to some simple local source of irritation is only an additional cause of annoyance.

To endeavor to prevent suppuration is, consequently, a wise course; this can best be done by rest and the local application of cold in the form of ice or lotions of lead, muriate of ammonia, or spirit. When suppuration is threatening or cannot be retarded, warm fomentations are the best; and as soon as pus has formed a free incision should be made, followed by warm-water dressing or a poultice. A vertical incision, as a rule, is the best; but when the abscess is large, the opening should be made in the long axis. The application of leeches or iodine to a bubo that threatens to suppurate seems a useless practice.

In the indolent bubo, or rather where indurated glands exist, local treatment it useless, though care should be observed that no local source of irritation is added to that of the sore and no excess of exercise taken by which the inflammation may be increased.

When the cellular tissue around the glands is infiltrated with inflammatory products, as indicated by its brawniness, etc., the value of local pressure by means of a pad and the spica bandage (Fig. 311, p. 542) is unquestioned, while tonics, rest, and other constitutional treatment are beneficial. The local application of some mercurial ointment at times appears to be of use, and a small blister or a strong solution of iodine or of nitrate of silver is of value in hastening either the absorption of the inflammatory products or their suppuration. As soon as suppuration appears the abscess should be opened. When a hard gland is left at the bottom of a suppurating wound, the American practice of applying such a caustic as the potassa fusa to its centre, to cause its death and subsequent sloughing, or Golding-Bird's electrolytic caustic, occasionally is of great use, this practice being as useful in syphilitic glandular enlargements as in others. In some instances the removal of the gland by the scalpel may be expedient. Sinuses must, if possible, always be laid open.

If phagedæna attacks a bubo, the local application of nitric acid or the actual or galvanic cautery is sometimes called for, more particularly when, in spite of general or other local treatment, it spreads. Opium, tonics, and other internal remedies must not be omitted.

HYDROCELE OF THE CORD AND OF THE TESTICLE.

Hydrocele, or a collection of serous fluid in close connection with the testicle or spermatic cord, is a term which has been applied to two classes of cases which differ in their progress as well as in their pathology and agree only in the one marked and prominent symptom, to which the term "hydrocele" is applicable. For clinical purposes, however, the word has certain advantages, and with this view may still be employed.

Accepting the term, therefore, as signifying a collection of fluid in close contact with the testicle or spermatic cord, two great divisions of the subject at once suggest themselves—namely, the *vaginal hydrocele* or the collection of fluid into some portion of the tunica vaginalis of either the cord or the testicle, and the *encysted hydrocele*, or spermatocele, which is an expanded and newly-formed cyst, as a rule, in connection with the epididymis, and but rarely with the body of the testis.

On the Formation of the Serous Sac.—It is well known to all who have studied physiology that in its descent from the loin during fœtal life the testicle draws with it into the scrotum two layers of peritoneum with its attendant nerves and vessels, and that all pass through the internal and external abdominal rings in front of the cord into the scrotum, the posterior layer of peritoneum being in close connection with the fibrous capsule of the body of the testicle—the tunica albuginea—and the anterior in connection with the purse, or scrotum. In a perfectly normal condition it is generally supposed that at birth, or shortly after, the two surfaces of this serous membrane close and become adherent, the canal which was at one time present ceasing to exist from the internal abdominal ring to the upper portion of the testicle, while in the scrotum the two serous surfaces remain permanently free, for the purpose of allowing easy and ready mobility of the testicle in its scrotal covering. It is now, however, well known that the prolongation of the serous membrane down the inguinal canal *into the scrotal sac* often remains patent for a longer period than has generally been supposed, and that in some cases it continues as a pervious canal during the whole of life. It is likewise known that *the vaginal process* of the peritoneum may be closed at the upper part of the testicle, but remain open above, during childhood, and even up to old age; also that this naturally-formed peritoneal tube and sac may be closed at the internal or external abdominal rings, or at any intermediate spot between these points, or at its junction with the testis.

As a consequence of these facts, it is tolerably clear that a collection of serous fluid may take place in any part of this prolonged serous channel, and that a hydrocele of the cord or testis of different kinds may be produced.

We thus find during infant and early life, from a want of closure of this tube at the internal ring, that a serous exudation may take place either into the cord alone or through the cord into the scrotal portion of this peritoneal sac. Under the former circumstances a *congenital hydrocele of the cord*, and under the latter a *congenital hydrocele of the testicle*, are said to exist. When the tubular portion of the canal is closed at the junction of the cord and testicle and the testicular part is open, *a simple vaginal hydrocele* exists; and when the tubular portion of the canal is closed only at the internal ring, the hydrocele may extend more or less up the canal, even as far as the internal ring.

In another class of cases the serous fluid may be confined between the internal and external rings, giving rise to the so-called *diffused hydrocele of the cord;* and when it occupies a still more restricted space, it is usually described as an *encysted hydrocele of the same part.*

The pathology of all these different conditions remains, however, the same, the different position of the fluid being accidentally determined by the extent and lines of adhesion or the closure of the peritoneal testicular prolongations. A congenital hydrocele may be complicated with a hernia. A reference to Figs. 292, 293, 294 (p. 524), given to illustrate the subject of hernia, will assist the student in understanding these points.

The Pathology of Hydrocele.

Acquired Hydrocele.—It may with considerable confidence be asserted that, as a general rule, the secretion of the serous fluid which gives rise to the ordinary vaginal hydrocele is due to an inflammatory affection of the tunica vaginalis, because in certain cases flocculi of pure lymph may be seen floating in the secretion, while in others spontaneous coagulation of the same may be observed. The thickening of the tunica vaginalis, moreover, which so frequently takes place in chronic cases, the presence of membranous bands and septa in the cavity of the serous sac, and the fact that this form of hydrocele may be produced by extension of the inflammatory action from the epididymis or the body of the testicle, point likewise to the same conclusion.

Congenital Hydrocele.—It is not, however, so clear that an inflammatory action has any influence in the production of the serous effusion in the congenital form of hydrocele, in which a communication still exists between the abdominal peritoneal cavity and the scrotal serous sac; indeed, it would rather appear as if the exudation was of a passive nature and merely an excess of the natural secretion of the serous membrane, since in many of these cases the fluid rapidly disappears under tonic treatment, being reabsorbed as the powers of the patient improve, and *vice versâ*.

The **fluid** of a vaginal hydrocele is invariably albuminous, and under the influence of an inflammatory action this is markedly increased; hence, the amount of albumen in the fluid of a hydrocele is determined by the nature and violence of the inflammatory action. In the congenital variety it is a thin, serous, and saline fluid of a clear color,

slightly tenacious and albuminous, the fluid differing in no single point from the natural serous fluid of the peritoneal cavity. In the acquired form it may present the same characters, but it is usually more tenacious and varies from a pale amber to a deep straw color. In some examples the fluid will be stained with blood, in others it will hold cholesterin in suspension, at times being perfectly opaque and syrupy from the presence of such matters. It is, however, in the old and chronic cases alone that these last conditions are to be observed.

In the **acute vaginal hydrocele** more or less fibrin will be found, either in solution or in the form of false membrane or adhesions between the two surfaces of the serous membrane; in the **chronic** the walls of the cyst will be found to have undergone great changes, the thin clear membrane having become thick and opaque, owing to the organization of the inflammatory product which had been poured out into its tissue, and in certain cases containing cartilaginous or ossific deposits, while on its surface it will present a firm fibrous appearance. In rare cases suppuration may occur in the tunica vaginalis, and even prove fatal. Thus, in 1883 a male child æt. 8 days was brought to Guy's with a red, swollen, glistening scrotum and the report that it had not passed urine for hours. The penis and the perinæum were healthy. A catheter was passed without difficulty and a few drachms of urine drawn off, but the child died next day. After death the urinary organs were found to be healthy, but the tunica vaginalis on both sides was full of pus, and, as the vaginal process of the peritoneum on both sides was open and communicated with the peritoneal cavity, there was evidence of peritonitis by extension.

Uncomplicated hydrocele, or a simple effusion into the tunica vaginalis, unassociated with any disease of the testis or epididymis, is generally a painless and insidious affection; it attracts attention mainly by its size, and demands treatment chiefly from the mechanical inconvenience it causes. It is generally of slow progress, and, as a rule, will be found to have existed for many months before being seen by the surgeon, the patient seeking advice only when the organ has become cumbersome and from its weight has excited some pain and dragging in the lumbar region.

The Clinical Examination of a Hydrocele of Testicle.

On examining a testicle the seat of this disease the enlargement will be found free and readily movable and to occupy the position of that organ which it includes. On inquiring into the history of the case it will be ascertained that the swelling appeared primarily in connection with the testis and gradually encroached upon the upper portion of the scrotum toward the external ring. On the surgeon grasping the neck of the tumor below the external ring he will at once feel the cord clear and distinct above the tumor. In exceptional cases, however, the fluid will be found to pass upward through the external as far as the internal ring, and in such examples the peritoneal testicular process has closed only at one point, and that is at its internal abdominal opening (Fig. 292). On taking the tumor in the hand it will be found to be light, and on passing the fingers over its surface it will be felt smooth and uniform. Fluctuation will also readily be detected on the slightest and most delicate palpation. The position of the testicle should then be looked for and made out, its natural site being somewhat posterior, and in large tumors toward the upper part. But it must be borne in mine that in certain examples—that is, in cases in which the organ is misplaced—the testicle may be in front of or below the tumor. The best test of its presence is afforded by manipulation, the peculiar testicular pain felt on the application of pressure affording a certain indication. The question of translucency should next demand attention; for when present, it is of peculiar importance and indicative of the vaginal hydrocele. It must be remembered, however, that such a symptom is not constant, since it is present neither in cases of hydrocele in which the fluid is thick, bloody, or opaque, nor when the walls of the vaginal tumor have become thickened by fibrinous deposit.

It should be added that for this translucency to be well observed the integuments of the scrotum should be firmly stretched over the scrotal enlargement.

The tumor is generally described as being of a regular and pyriform shape, but this condition is very variable, since the shape of the swelling depends upon the openness of the tubular peritoneal membrane of the cord and the connection which exists between the surfaces of the tunica vaginalis testis and tunica vaginalis scroti. When the canal has closed and withered down to the body of the testis, the swelling will be more or less globular; and the higher the point of closure of the vaginal peritoneal sac toward the internal ring, the more pyramidal will the watery swelling necessarily become. If adhe-

sions exist between the two layers of serous membrane at the lower portion of the testis, the hydrocele will appear to be at the upper part; and when the natural contraction between the tunica vaginalis of the cord and of the testicle is not completed (Fig. 294), an irregular, or even an hour-glass, contraction may make its appearance, the outline of a hydrocele depending much upon the anatomical conditions of the part in which it is situated and the pathological changes which may have resulted from the affection. The true pyriform swelling is best seen in children, in whom the fluid will frequently be found to pass well up the cord; in adults it is not, however, uncommon.

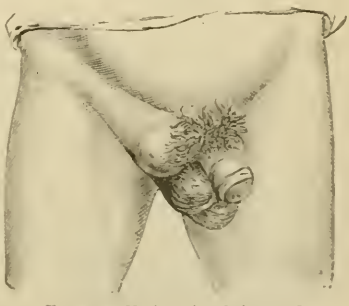
Hydrocele occurs at all ages, but it is somewhat common at birth and middle age, and in a large proportion of cases appears as a one-sided affection and seems to affect the right or left testis indiscriminately. Curling informs us that of 115 cases, 65 occurred on the right side, 44 on the left, and 6 were double; while out of 117, my own cases, consecutively observed, in which these facts were noted, 41 occurred on the right side, 62 on the left, and 14 were double—results coinciding with the opinions of Velpeau, Gerdy, and others.

General Summary.—By way of summary, it may be said a chronic vaginal hydrocele appears as a painless enlargement of the testicle, of slow and unequal growth, and of variable size, with a smooth and uniform surface and more or less tense and fluctuating feel. It is invariably movable within the scrotum, and, as a rule, appears to be distinct from any abdominal connections. The presence of the testis within the swelling can generally be made out by the testicular pain which is produced by pressure at its posterior and upper portion if the tumor be large, and at its lower if small, or by the absence of translucency at one spot, the tumor, as a rule, transmitting light when its serotal coverings have been well stretched. It has a tendency to remain tranquil for many years, and by age simply increases in size. It occasionally grows to enormous dimensions, when the penis may become buried within the swelling, but never proves dangerous to life. It causes pain and requires treatment mainly from mechanical causes.

Hydrocele of the Cord.

Symptoms and Diagnosis.—It has been already briefly explained how a hydrocele of the cord may be produced, and under what circumstances it may appear as a *diffused* or a so-called *encysted* tumor. It has likewise been shown how these two conditions are but modifications of the same disease, the diffuseness or isolation of the affections being determined by the adhesion or more or less complete closure of the vaginal process of peritoneum as it passes downward into the scrotum. Thus, a *congenital hydrocele* of the cord will be present when, from a want of closure at the abdominal orifice of the vaginal peritoneal process, serous fluid can gravitate downward toward the testis. A *diffused hydrocele* of the cord will be said to exist when, either at an early or a late period of life, serous fluid collects in the vaginal peritoneal process, which is closed above at the internal ring and below at any point above the upper portion of the testis, while in a third class of cases an *encysted hydrocele* of the cord may appear as a small isolated bag of serous fluid movable with the cord and connected with it, situated between any of these points (Fig. 420), its circumscribed nature having been determined by a more complete closure of the vaginal peritoneal process and the limited space into which the effusion has taken place.

Fig. 420.



Encysted Hydrocele of the Cord.

Pathology.—Under all these conditions, however, the pathology of the affection is the same, and the symptoms indicating its presence vary only according to the size and tension of the sac which contains the fluid. In the congenital form, in which a communication exists with the peritoneal cavity, the hydrocele will fluctuate and have a smooth and uniform outline, but it can never be tense. It will also disappear more or less readily by pressure or by elevating the testicle on the patient assuming the recumbent position, when the fluid will gravitate into the abdominal cavity with a rapidity which varies according to the size of the peritoneal communication.

In the diffused hydrocele of the cord this disappearance of the swelling by rest or pressure will not take place, for in such the opening of the vaginal process will have closed naturally. The tumor will thus appear as a baggy or tense elastic swelling in

the inguinal canal, which it will more or less fill. It will give to the hand a sensation of fluctuation, and in certain instances may appear translucent. It will, moreover, on any traction of the testicle, be found movable and painful in proporrtion to the amount of tension of the cyst or of the inflammatory action.

In the more localized or apparently cystic hydrocele of the cord the same symptoms will present themselves. The tumor will be more isolated, probably more movable and more tense, and it will be readily acted on also by any traction on the testis. It may occur as a single cyst or as many cysts, but each will present the same symptoms. When a single, tense, movable cyst exists, it may be mistaken for a distinct morbid growth; but the diagnosis of the case ought not to be difficult when care is observed. Fig. 420 well illustrates the ordinary appearance of the affection.

Treatment of Vaginal Hydrocele of the Testis.

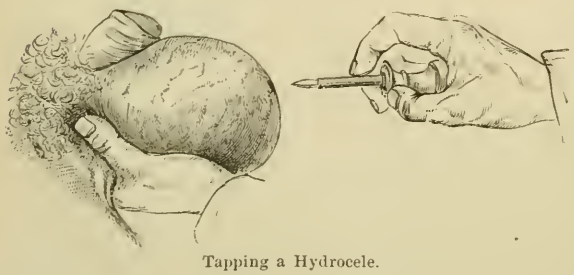
In the *congenital hydrocele* of young life surgical treatment should be very simple, for the disease, as a rule, readily disappears with age and increasing strength. A little cold lotion applied to the part, such as a solution of the hydrochlorate of ammonia, and tonic medicine, is frequently sufficient to effect a cure; for, as I have already stated, the effusion into the vaginal sac in these instances seems to be often of a passive nature. The hydrocele found in infancy is not, however, always of the congenital form. A hydrocele may exist in an infant in which there is no communication with the peritoneal abdominal cavity through the neck of the vaginal process, and under these circumstances a different treatment may be required. Cold lotions and tonics may be of use, and certainly should be primarily employed; yet in many instances the treatment will fail to cure the case. *Acupuncture* may be then employed and the fluid allowed to escape into the cellular tissue around the sac, when it may be altogether removed by absorption; but this treatment is not, as a rule, satisfactory, it being exceptional for a permanent recovery to be secured by such means, and I am disposed to think it better practice to draw off the fluid by means of a fine trocar and canula, and to excite some fresh action in the membrane lining the tunica vaginalis by stirring it up with the end of the canula. This practice has been very successful in my experience.

In early examples, when the hydrocele is still small and consequently of little inconvenience, it is well, perhaps, to leave it alone; for unless it causes anxiety to the patient or proves troublesome or inconvenient from its size, there is no necessity for interference. *In very old people* it is as well not to interfere unless a strong necessity exists, as sloughing of the scrotum, suppuration of the sac, and other bad results occasionally occur in these cases from slight causes. It must be added that the feelings of the patient as to the amount of pain and inconvenience are the best guide to interference, very slight enlargement causing as much pain in some patients as a greater increase in others. If, then, some treatment be demanded, simple tapping should be performed as a primary measure, the fluid being drawn off by means of a moderate-sized trocar and canula. In doing this some care is necessary, although the operation is really simple, as difficulties are often made by the operator, while dangers result from want of caution.

The Tapping of a Hydrocele.

As a point of primary importance, the true position of the testicle should be defined. In the majority of cases it will be found at the posterior part of the tumor and toward its lower part, unless the hydrocele be very large. At times, however, as has been observed, it will be found in front, from a congenital malposition, as well as in certain other cases which are difficult to explain. The true position of the gland can generally be made out by manipulation, and further by the want of transluceney in the tumor at the part it occupies. Having made out to a fair certainty the position of the testis, the tumor should be taken in the left hand and grasped firmly at

Fig. 421.



Tapping a Hydrocele.

its neck, the surgeon taking care, at the same time, to stretch the integument well over the cyst and to render its wall tense and unyielding (Fig. 421). The trocar, with well-fitting cannula (having been previously well oiled), should then be taken in the right hand, with the index finger placed about three-quarters of an inch from the extremity of the cannula, while the front of the thumb rests on its flange. The object of this position of the finger is to prevent the instrument going in too far with a rush and thereby endangering the testicle; the object of that of the thumb is to press home the cannula as the trocar is being withdrawn. The tumor should be punctured at its lower part, care being taken to avoid any large vein, and the fluid allowed to run out. Having completely emptied the cyst, the punctured integument should be firmly held and nipped up with the thumb and finger of the left hand, and the cannula should be withdrawn. A little cold air or the irritation of the finger generally causes sufficient contraction of the dartos to close the wound and prevent hemorrhage or any further escape of the remaining fluid. A piece of lint, however, may be applied over the puncture for purposes of cleanliness and to prevent friction.

In certain examples of this disease in the adult I have been induced to stir up the cyst as I have described in the hydrocele of the young, and have met with some success. In no instance has any evil consequence resulted from the practice, and in several a cure has taken place, evidently from inflammation. I would advise this practice to be confined, however, to young adults. As a palliative practice it is scarcely necessary to recommend any other than that described, as it is simple, more efficacious than any other, and not more dangerous. Acupuncture has been advised, but it has no practical advantage over the simple tapping, and it is certainly less successful in its result. In exceptional cases it may be good, particularly in such a case as Mr. Curling has described, on the authority of Mr. Luke, of a gentleman who was about to proceed to a part of the world where surgical advice could not be secured, and where the patient could then perform this simple operation on himself. I have more than once known a patient to tap himself.

The period of relief which a patient experiences from a simple tapping varies exceedingly from a few weeks to many years, and even in the same patient the interval will be found to vary from time to time. In the young and middle-aged adult, when the general health is sound and a return of the effusion has taken place, unless any personal objection should be made, it is generally advisable to adopt some plan for a more permanent cure. In old men it is the soundest practice to rest satisfied with the palliative treatment, and in such the radical cure should be proposed only in exceptional cases.

Treatment of Hydrocele of the Cord.

The principles of treatment which have been laid down in cases of hydrocele of the testis are likewise applicable to those of hydrocele of the cord, their application requiring only such modifications as may be demanded by the altered position of the affection. In the *congenital* hydrocele no special treatment is required, because as strength comes to the child the fluid probably will be reabsorbed; failing this result, tonics should be given to expedite the cure, and some cold lotion, such as the chloride of ammonium with vinegar ʒj to Oj, should be applied.

In the *diffused* or *encysted* hydrocele of the child or adult more active treatment is frequently, though not in all cases, demanded; the fluid will at times disappear without treatment, though it may recur at a later date; still, the affection ceases to trouble, and unless some real inconvenience is produced by its presence it is as well to leave things alone. When, however, pain or inconvenience is experienced, something must be done; and no doubt the best practice is to evacuate the fluid. In small, tense, encysted hydroceles the practice of evacuating the fluid by acupuncture is certainly sound, since tapping by the trocar and cannula is an operation of some difficulty where the cyst is small. It may be done with any needle, but those employed for cataract are probably the best, and several openings should be made. Tapping may be employed as in any other case of ordinary hydrocele. I have on several occasions effected the radical cure by injection, and have not met with any bad results. When this treatment fails and further measures are demanded, as a last resource an incision into the cyst may be made.

Radical Cure of Hydrocele.

It is not necessary to review all the various plans which have been, and are now, employed for the permanent cure of a hydrocele of the tunica vaginalis. It will be

more to the purpose to give the line of practice which is most successful, and which at the same time is very simple—viz., the injection of the cyst with a solution of iodine. It is not, perhaps, a question of much importance whether the fluid should be concentrated or diluted, or whether it should be permanently left in the cyst or withdrawn after a few minutes have been allowed for it to act upon the secreting surface; such minor differences may be left to the fancy of the operator. My own judgment leans toward the practice of injecting from two to four drachms of a mixture of equal parts of the tincture of iodine and water and allowing it to remain, care being taken that the canula is previously well pushed home into the cyst, and that no iodine solution is allowed to escape into the cellular tissue outside the sac. By this practice a radical cure is almost certain to be secured, and only exceptionally does any failure or evil result follow. The American surgeons are fond of injecting from half a drachm to a drachm of pure carbolic acid liquefied with water or glycerin into the sac, and, Dr. Levis reports, with success. In obstinate cases a free incision into the tunica vaginalis and the filling of the cavity with carbolic or iodoform gauze, to make it fill up by granulation, is also to be recommended. When a cure does not occur, it is generally due to the fact that a hydrocele has been injected when some inflammation of the testicle coexists, and from which it has been produced. In all examples of hydro-testitis the practice of injection must be looked upon as injurious and as treating the result of a disease, and not the disease itself—the effect, and not the cause. Within the last few years, where the iodine has failed, I have often used warm water as an injection. It answered well, but set up more inflammatory action than the iodine; indeed, in several cases it excited suppuration. Some of the Dublin surgeons speak highly of the practice of introducing into the sac of the tunica vaginalis a grain or more of the biniodide of mercury made into a paste with some grease, and I have followed this practice in some cases with advantage. I prefer, however, the iodine treatment.

Encysted Hydrocele of the Testis.

On examining the testis of the adult after death it is by no means an uncommon occurrence to meet with small cysts connected with the epididymis. These may be single or multiple, and in many instances are very numerous. These cysts are generally more or less pedunculated, and, as a rule, are connected with the upper portion of the epididymis. They are filled with a clear, watery fluid which contains, in certain cases, some granules.

Pathology.—The pathology of the formation of these cysts is somewhat difficult to understand, and surgically is of small importance, since they seldom, if ever, become of sufficient size to cause inconvenience or to require any operative interference; indeed, they are rarely diagnosed during life, and are discovered only on post-mortem dissection.

Another kind of cyst is occasionally met with connected with the testis, and in close contact, if not associated, with the epididymis. It has been described as the encysted hydrocele. It springs from the same part as the smaller cyst, but grows to much larger dimensions and generally contains a very different kind of fluid. Its origin is as obscure as the former kind of cyst. It enlarges very slowly, does not give rise to any pain, nor does it produce any inconvenience other than that caused by its size. It seldom requires treatment in its early stage, and, as a rule, many years are allowed to pass before interference is demanded, the tumors frequently developing for twenty years or more before advice is sought. These cases are by no means so common as the ordinary vaginal hydrocele, not more than five per cent. of the cases of hydrocele being of this kind.

A cyst is occasionally developed between the tunica albuginea of the testis and the tunica vaginalis testis, the pathology of which is very obscure. Mr. S. Osborne suggests —and I think with good reason—that this is merely an enlargement of the corpus or hydatid of Morgagni, a constant structure, existing as a pedunculated vesicle situated between the summit of the globus major and the body of the testicle, between the visceral layer of the tunica vaginalis and the tunica albuginea (*St. Thomas's Hospital Report*, 1874). Cases of this kind are described by Curling and Hutchinson. Guy's Museum contains a specimen. I know of no means of diagnosing their existence. Their treatment would be similar to that of other cysts.

Symptoms and Diagnosis.—In an early stage of encysted hydrocele the diagnosis is not difficult, as the cyst usually appears as a kind of budding of the testis, or rather of the upper portion of the epididymis; as a tense, hard, globular, and in some cases pendent, tumor more or less intimately connected with some portion of the spermatic

duct. It is generally discovered on the part of the patient by accident, and when as large as the natural testicle has been occasionally set down as an extra organ.

The surgeon is not often consulted in such a case in its early stage, the tumor usually having been allowed to grow to an inconvenient size before advice is sought. In forming a diagnosis the history of the case will often at once throw some light upon its nature, and in all probability it will be found that the increase has been extremely slow, twenty years or more often intervening before the cyst attains anything like a large size. These encysted hydroceles probably never grow so fast nor acquire such dimensions as the more common vaginal species.

The next feature demanding attention in the development of these cysts is their shape and outline, which are often rather striking. They never in their early stage, and rarely at any time, assume the appearance of ordinary vaginal hydrocele, and almost always maintain a globular outline.

The position of the testis in its relation to the cyst next claims attention, and a marked difference exists between the encysted and the vaginal hydrocele. In the vaginal, as a rule, it is to be found at the posterior part of the sac when the tumor is small toward its lower, when large toward its upper, part. In the encysted it is to be found in front, to one side, or below, and rarely at the posterior part. The reason for this is easily explained. The cyst is usually connected with the epididymis, which normally lies at the posterior part of the gland.

The nature of the cystic contents differs also in many points from the fluid of a vaginal hydrocele, and is very characteristic. In the *vaginal* hydrocele the fluid has been described as being generally clear, like the serum of the blood, more or less albuminous, of a straw color, and at times spontaneously coagulable, blood and cholesterin also being occasional elements. In the fluid of an *encysted* hydrocele none of these elements are generally present, but, as a rule, it is a limpid, feebly saline, watery liquid; at times it is slightly opalescent, as if mixed with milk, and then it will be found to contain some granules in suspension, and frequently spermatozoa. Cystic hydrocele differs from the vaginal in the slowness of its growth, its globular outline, the anterior position of the testicle, and the nature of its cystic contents.

The origin of the spermatozoa in these cysts is a point of peculiar interest, and has been a disputed point with pathologists for many years. Mr. Curling's investigations on this subject have proved that in some instances their presence is certainly due to the rupture of one of the spermatic tubes which pass over and are in close connection with the walls of the cyst, this rupture generally taking place from an injury and being indicated by some rapid increase in the size of the cyst. Mr. Curling has shown that this history was given in several of the cases in which spermatozoa were found, and in some he was even able to demonstrate a distinct communication between the cyst and the spermatic tube. The following case tends to support his views. Robert P——, æt. 60, came under my care at Guy's Hospital on December 28, 1863, with an encysted hydrocele of the left testicle of twenty years' growth. The increase had been very slow until the last month, when the tumor had doubled its normal size, this rapid growth having followed an injury produced by a fall. When first under my observation, the scrotum contained an irregular cystic tumor on its left side, evidently made up of several cysts, of which three of large size could readily be distinguished, two being very tense, while the third was baggy. The testis was found on the inner side of the tumor. Tapping was at once resorted to and the largest cyst emptied, many ounces of a milky fluid being drawn off. The second tense cyst was then tapped through the same opening, with a similar result, and the fluid collected in a distinct glass. The third cyst was also tapped, but in this the fluid was quite watery. The first two contained abundance of spermatozoa, while the third did not contain any. A good recovery took place.

Treatment of Encysted Hydrocele.—However interesting the two forms of hydrocele which we have just been considering may be, both in their pathology and in their points of difference, the treatment in the two cases is practically alike. When anything is required to be done, simple tapping may suffice, and as a primary measure it should always be preferred; but, should the radical cure be required, the injection of iodine may be carried out. The slow growth of these cysts, however, and the equally slow reaccumulation of their contents after tapping, are points which indicate the propriety of adopting the palliative treatment in the majority of cases.

Ruptured Hydroceles

It is well known that in children hydroceles, as a rule, disappear spontaneously with little or no treatment, but in adults such a result is most uncommon. Messrs. Pott, Curling, and Sir B. Brodie relate cases of this kind, and attempt to explain the process by which such a recovery takes place with more or less success. A single instance of the kind has passed under my hands for treatment.

Charles C——, æt. 64, came to Guy's Hospital on January 29, 1863, with a hydrocele of the left testis the size of a cocoanut. It was of two years' standing, and had been tapped six times, under my care each time. He came under my notice, at length, when I was about to leave the hospital, and I did no more than examine the parts, which were tense and painful, telling the patient to return to me in the course of a few days to be relieved. When he came the following week, all indication of swelling had completely disappeared, the man assuring me that he had gone to bed the night of the second day before his visit with a large tumor, and that when he awoke it had disappeared. He added also that on the following morning he had passed a large quantity of thin urine. The patient was a steady man and a widower, and told his tale with all the appearance of truth and with some astonishment. In three months the fluid had again collected, and he was tapped. This case was doubtless an example of subcutaneous rupture of the tunica vaginalis.

In the following cases the rupture took place without hemorrhage. Rob. M——, æt. 66, came under my care in 1879 for a hydrocele of the right testis. It commenced six years before and steadily increased up to one year and a half ago, when he accidentally struck it, and in four or five hours the whole swelling had disappeared. He remained well for three months, when it began to increase, and on admission the tumor was the size of a fist. It was tapped and injected with iodine with success.

At times rupture of the tunica vaginalis is followed by a blood tumor, and this occurs when any large vessel is ruptured. It took place in the following case.

R. B——, æt. 50, came under my care in July, 1879, with a large scrotal tumor. He said that his right testicle had been large for years, but that he had never been tapped. Four days before his admission, when sitting at his desk, he felt a pain in his scrotum, and on putting his hand to it he found it enlarging, whilst the swelling of the testicle was rapidly diminishing. The scrotum continued to increase for three days, when it ceased to do so, and he came to Guy's. When admitted, the scrotum was very large and in circumference measured twenty-three by sixteen inches. It was uniformly smooth and but slightly painful. The groin had an ecchymosed appearance and was brawny. Ice was applied. On the fifth day I cut into the tumor and evacuated from the scrotal integuments a mass of blood. Having done this, a rent about two inches long was clearly visible in the tunica vaginalis, and within this cavity was blood-stained serum and clot. On turning this out the testicle was visible. The cavity was cleared out, washed with iodine water, and drained; and in the course of two weeks the patient was well, the cavity having granulated.

The nature of these cases is not generally recognized.

HÆMATOCELE.

As the term "hydrocele" is applied to the effusion of serous fluid into the sac of the tunica vaginalis and of its tubular prolongation upward to the internal ring, as well as into the cysts which have been already described as being connected with the testis, so the term "hæmatocele" is employed to designate an effusion of blood into the same parts. We thus have—

A *vaginal* and an *encysted* hæmatocele of the *testis*.

A *diffused* and an *encysted* hæmatocele of the *cord*.

Hæmatocele may occur in an organ which had not previously shown any symptom of disease, or it may be associated with a hydrocele. It may appear spontaneously without an injury or as the result of a blow, strain, or the tapping of a hydrocele. It may attack patients at any period of life, and in certain rare cases at a very early age, even in infancy. I have the records of a case in which it was said to have made its appearance at two years of age.

In the notes of my cases various causes have been assigned for its production. In more than one instance "it appeared gradually without any known cause." In another "it occurred when hard at work pushing a wheelbarrow, something giving way with a

snap." In the majority it came on as an immediate consequence of a blow, and in several as the result of the tapping of a hydrocele. In all, however, the result was the same—a more or less rapid formation of a tumor in the position or neighborhood of the testicle.

Symptoms and Diagnosis.—The symptoms of a hæmatocele which has made its appearance without any injury or assigned cause are very obscure, and are pretty well summed up in the prominent one of a gradual and uniform enlargement of the organ. The swelling will vary in shape, as in a hydrocele, but, like it also, may present a more or less pyriform outline. The testicle will always, in the vaginal hæmatocele (on careful manipulation being made), be detected somewhere in the sac, and usually at its posterior and lower part, the peculiar testicular sensation being produced by slight pressure.

When caused by a sudden strain or injury, the enlargement will be more sudden as well as rapid, and be found to follow close upon the receipt of the accident, while the rupture of the blood vessel may be announced by the sensation of a sudden snap or giving way.

The local symptoms are similar to those already described.

The tumor, on its first appearance, may be somewhat soft and obscure or clear fluctuation may be detected in it; but if much time be allowed to pass before coming under observation, this fluctuation will not, in all probability, be made out, for the effused blood rapidly coagulates and gives rise to the sensation of a solid growth. The sac of the hæmatocele, whether tunica vaginalis or cyst, rapidly alters in character and becomes thick, and in certain cases fibrinous, or even cartilaginous, at first from the coagulation of the fibrin of the blood upon its inner surface and in cases of longer standing from distinct inflammatory changes brought about by the presence of the blood acting as foreign matter. In some instances this thickening of the cyst is very great, even to the extent of half an inch.

When a hæmatocele has followed upon a hydrocele, there will usually be a sudden enlargement of the part after the strain or injury, accompanied with more or less pain, this pain apparently depending upon the amount of distension to which the cyst has been subjected. If it follows the operation of tapping, it will, as a rule, be recognized by the escape of more or less blood or bloody fluid at the time of operation and the rapid refilling of the hydrocele sac or cyst with a more solid and opaque material.

To form a correct diagnosis of hæmatocele the history of the case is most important—indeed, more so than the local symptoms; for it is certainly true that by the latter alone, in some instances, it is almost impossible to make out the true nature of the affection.

Summary.—By way of summary, it may be stated that a hæmatocele is usually a uniformly smooth, tense, and *non*-transparent tumor with an *indistinct* sensation of fluctuation, but with *distinct* evidence of testicular pain on pressure. It may be accompanied with pain during the early period of the affection, from the distension of the cyst, but not at a later date or during its chronic stage, unless softening down. As time passes, it will become harder if no symptoms of inflammation show themselves, but on their manifestation evidence of suppuration will soon appear; for hæmatoceles have not, as a rule, a disposition to remain quiet, like hydroceles, but tend to open outward by the breaking up of the coagulated blood which has been effused, and the inflammatory process.

The symptoms which indicate the presence of a *hæmatocele of the spermatic cord* are somewhat similar to those already described for vaginal hæmatocele, the difference in locality being remembered. It is generally produced by a blow or strain, as in the ordinary vaginal hæmatocele. It can be diagnosed by the suddenness of its appearance or the suddenness of the enlarged hydrocele sac, by the opacity of the swelling and tendency to consolidation which it possesses, also by the accompanying ecchymosis of the parts. Cases are recorded by Bowman, Curling, and others in which this disease obtained enormous dimensions, but such examples are very rare, the affection being very uncommon.

Source of the Blood.—A very common question with students is as to the origin of the blood in these cases of hæmatocele, and in the spontaneous cases and those following a strain or injury with an apparently sound testis this question is difficult to answer with certainty of accuracy. There can be little doubt, however, that a distinct rupture of some of the vessels—probably veins—which ramify upon the body of the testis or on the tunica vaginalis must have taken place.

When occurring upon a hydrocele or after the operation of tapping, it is probably due to the distinct rupture or perforation of one of the large veins which ramify outside the tunica vaginalis, into its interior, or of one belonging to the body of the testis.

Scarpa relates a case of hæmatocele in which the spermatic artery was wounded, and

Sir A. Cooper another, in which a distinct rent in the tunica vaginalis was found on dissection. This latter condition is probably the most common.

Treatment.—The treatment of hemorrhage into the tunica vaginalis testis, or cord, differs in no respect from the treatment of hemorrhage into any other part of the body. In the very earliest period of its occurrence rest in the horizontal posture with the testicles well raised and the application of cold, either as ice in a bag or by means of the metallic tube, are the most efficient means to arrest the flow of blood and relieve pain. By such means the blood may also be reabsorbed and all future mischief prevented. Should the blood, however, remain fluid for a long time and no symptoms of reabsorption or of inflammatory action manifest themselves, it is a sound practice to draw off the fluid contents with a trocar and cannula. I have had a case in which this course was adopted with good effect.

If signs of inflammation appear soon after its occurrence, cold lotions and leeches, with the aid of saline purgatives, may occasionally be found efficient in arresting its progress and to allow of the subsequent reabsorption of the effused blood. But should symptoms of suppuration show themselves, or of the softening down of the coagula, a free incision into the cyst or tunica vaginalis is the only sound practice, the whole semi-solid contents being thoroughly turned out and the interior of the sac allowed to granulate. In old and chronic cases with thickened sac walls the same treatment is also effectual. I possess the records of many cases in which this plan was carried out with marked benefit —in one case of only four months' duration, and in another of twenty-nine years', in which the tunica vaginalis was at least half an inch thick, and in both a good recovery followed. I need hardly add that excision is rarely called for in the treatment of these cases, although, owing to difficulties in the diagnosis, recourse may occasionally have been had to it. I have seen several such instances, but beyond the loss of the organ no evil resulted. In old cases of hæmatocele in aged subjects the practice of excision is probably the best, but in the young and middle-aged it cannot be advised. The treatment of hæmatocele of the cord is to be conducted on similar principles.

ON DISEASES OF THE TESTICLE.

Inflammation of the Testicle.

Under the term *orchitis* most authors have been in the habit of including the inflammation of two distinct portions of the testicle and of mixing up the symptoms of two affections, to the prevention of a sound and clear understanding of the subject. In this chapter I shall separate the two and describe inflammation of the epididymis as one affection and inflammation of the true secreting gland as another, calling the former *epididymitis* and the latter *orchitis*. In certain cases, it is true, both structures are involved in the inflammatory action, and to this state I shall apply the term *testitis*, the three words accurately indicating the true seat of the malady, their use consequently tending to facilitate its better study.

All surgeons will be ready to admit the distinctness of these two parts anatomically and physiologically—viz., the epididymis and the gland. It is as well also to acknowledge that pathologically they are constantly divided, and I am certain that to the student of the affections of this organ such a division tends to a more ready discrimination and appreciation of the several diseases of the testicle.

As a preliminary to the more special clinical and pathological consideration of these diseases, the following observations of Sir J. Paget, as given by Curling, upon the development of the epididymis and testis may be read with interest and advantage.

Sir J. Paget observes "that in the normal course of human development the proper genital organs are in either sex developed in two distinct pieces—namely, the part for the formation of the generative substance, the testicle or ovary; and the part for the conveyance of that substance out of the body, the seminal duct or ovi-duct. The testicle or ovary, as the case may be (and in their earliest periods they cannot be distinguished) is formed on the inner concave side of the corpus Wolffianum, and the seminal or ovi-duct, which is originally an isolated tube closed at both extremities, passes along the outer border of that body from the level of the formative organ above to the cloaca or common sinus of the urinary, genital, and digestive systems below. The perfection of development is attained only by the conducting tube acquiring its just connections at once with the formative organ, and through the medium of the cloaca with the exterior of the body. The sexual character is first established when in the male the formative and conducting

organs become connected by the development of intermediate tubes which constitute the epididymis, or when in the female a simple aperture is formed at the upper extremities of the conducting tube and is placed closely adjacent to the formative organ. In both sexes alike the lower extremities of the conducting tubes first open into the common cloaca, and subsequently, when that cavity is partitioned into the bladder and rectum, or bladder, vagina, and rectum, they acquire in each their just connections, and become in the male the perfect vasa deferentia, and in the female Fallopian tubes and uterus."

I will remind the student that the epididymis naturally forms the posterior and outer part of the testicle, and the secreting portion or true gland the anterior; that the former in a perfectly healthy state is only indistinctly felt, the vas deferens, on being traced downward from the cord, losing itself, as it were, in this part. The body of the gland can always be made out by its smooth and elastic globular form.

Epididymitis, or Inflammation of the Seminal Duct.

Inflammation of the epididymis may be caused by some local inguinal injury or the pressure of a truss, but, as a rule, it is a consecutive affection and occurs in association with a urethritis, gonorrhœal or otherwise, or as the result of some irritation of the prostatic urethra, such as the presence of a calculus or the passage of a sound or lithotrite. It is caused by an extension of inflammation from the urethra down the vas deferens to the epididymis, and is an inflammation of the seminal *duct*, and not of the seminal gland. It generally comes on suddenly and is attended with considerable pain, a marked enlargement of the epididymis or posterior part of the testicle forming its chief local symptom. It is constantly preceded by severe pain in the anal and iliac fossæ and accompanied by special tenderness of the part, this tenderness being readily traceable up the cord, which is occasionally swollen and œdematous. It is usually attended with œdema and redness of the scrotum over the inflamed tube.

The enlargement of the epididymis is very rapid, and in some instances very great. It invariably assumes a special outline when uncomplicated—that is, when confined to this special part—the epididymis appearing of a boat or truncated half-moon shape, holding the body of the testicle in its concavity. The lower portion of this body is usually the most enlarged, being composed of the greater number of the convolutions of the tubes, and consequently containing more connective tissue, since it is from the infiltration with inflammatory effusion of this connective tissue around the inflamed seminal duct that this enlargement is produced.

The affection generally is acute, comes on suddenly, runs a rapid course, and is accompanied in most patients by some constitutional disturbance. In some subjects this is very severe, while in others it is of a milder description, the sharpness of the inflammation and the peculiarity of the patients influencing the severity.

It is at times, however, complicated with other conditions, such as an inflammation of the true secreting portion of the testicle; but this complication invariably occurs as a secondary symptom, and is produced by the direct extension of the disease from the seminal duct to the gland. I have never seen a genuine orchitis or inflammation of the seminal gland as a result of gonorrhœa, except as an extension of the inflammation from the epididymis, and it is in quite exceptional examples of this affection that the body of the testicle is ever involved.

When the inflammation has extended to the gland itself, the diagnosis is readily made, the enlargement and great tenderness of the part clearly indicating what is the matter. The whole organ presents an expanded but flattened aspect, the swelling of the epididymis posteriorly and of the body of the testis anteriorly producing this peculiar laterally flattened outline. The two inflamed parts will, however, be always felt distinct from each other and can be readily distinguished. There is, however, a second complication of epididymitis more common than that just described, which is the effusion of fluid into the tunica vaginalis, or the production of an acute hydrocele; and I am disposed to think that it is this apparent swelling of the organ which has given rise to the mistaken idea that orchitis is a common affection after gonorrhœa. The enlargement of the organ from such a condition is, however, very different from that already described as due to an inflamed gland. It is more globular, tense, and elastic; it is certainly equally painful with that affection, but its true nature can be readily made out by its translucency and the presence of fluctuation on palpation. It is the result of a direct extension of the inflammation from the epididymis to the tunica vaginalis, and the following explanation of its occurrence by Gendrin, as given by Curling, who assents to its soundness, seems most

satisfactory, since it is certainly borne out by clinical observation. He says, "When the subserous cellular tissue, which always participates in the inflammation of a serous membrane, penetrates into the interior of an organ, it becomes a ready means of communicating the inflammatory action; but when the contiguous organ in subjacent parts is of a different structure from that of the cellular tissue, the extension of inflammation inward is checked. Thus, in the case of the inflamed tunica vaginalis the cellular tissue readily transmitted the morbid action to the epididymis, but the tunica albuginea arrested its progress to the body of the testicle; and this explains the fact that after inflammation of the tunica vaginalis excited by injection the body of the gland is rarely found to suffer. On the other hand, the epididymis is seldom attacked with inflammation without the disease being quickly propagated to the tunica vaginalis. The hydrocele, as a rule, however, disappears as the disease subsides in the epididymis, it being exceptional for the former condition to remain when its cause has been removed.

As a consequence of this epididymitis, it is by no means uncommon for a considerable thickening of the seminal ducts and of their surrounding cellular tissue to remain for many weeks, or even months. In the majority of cases, however, this result does not take place; for in the healthy subject there is every reason to believe that with the inflammation all effusion disappears and the organ is left as sound as it was before. In the cachectic patient this happy event does not, however, always take place, and more or less thickening of the inflamed part will generally be observed, the epididymis feeling indurated and enlarged and in parts nodulated and cordy. It has been a disputed point by pathologists whether this condition ever leads to an atrophy or destruction of the testicles or whether it has any influence upon the true function of the organ in causing sterility, and upon this point I have no positive facts to adduce, though I have certainly seen a wasting of the glandular structure of the testicles after inflammation the result of an epididymitis. In one instance I witnessed inflammation of the body of the testis in a young man who married at a time when he had a marked induration of the epididymis the result of an attack of inflammation some months previously. I entirely attributed the inflammation in his case to the retention of seminal secretion from the obstruction to the seminal duct the result of the old epididymitis, since we know that all ducts or canals, when surrounded by organized inflammatory products, are liable to obstruction or stricture, and it is only right to believe that the spermatic ducts are obedient to the same law, although this result may not be very common.

On the dictum of Sir A. Cooper it has generally been asserted that the left testis is more often attacked in cases of epididymitis than the right, but Curling's figures and my own disprove the truth of this assertion, and show that in 202 cases of this affection the right testis was the seat of the disease in 113 examples, the left in 74, and both glands in 15. *The right organ is, therefore, more often affected than the left*, while in hydrocele the *left* side is the most frequent seat of disease.

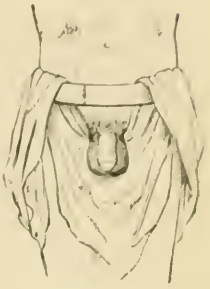
With respect to the cause of the disease, I took some pains during the eight years I was registrar at Guy's to find out the correctness of the general opinion that the epididymitis usually supervened on the disappearance of the urethral discharge and was relieved on its reappearance, or if it could be traced to any peculiarity in the treatment of the gonorrhœa, to any neglect, or other cause. I have to confess that I was not able to connect these phenomena in any way, as the epididymitis made its appearance during all stages of the complaint and under every kind of condition—when injections were employed, and when they were not: when copaiba and cubebs had been taken, and when they had not—although in some cases the diminution of the discharge and appearance of the epididymitis were coincident; but such a result is only consistent with the general rule that an inflammation set up in one part tends to relieve an inflammation existing in another, and more particularly in a neighboring tissue. The disease, however, appeared in the majority of cases of neglected gonorrhœa, and in others in which strong injections had been recklessly employed, but more particularly in the cachectic and irregularly living patients who had been utterly regardless of their affection and taken no means to keep the testes well suspended.

Treatment.—The treatment of this affection must depend upon the intensity of the inflammation and the severity of the local and constitutional symptoms which it produces. Rest in the horizontal posture, with elevation of the testes, or even of the pelvis, active purgatives, with saline medicines, combined in acute cases with tartar emetic or colchicum wine, are advantageous; the local application of ice, hot poppy fomentations, or swathing the parts in cotton-wool are often sufficient to check the disease at its onset and prevent its passing into a chronic stage. It is also a wise measure to administer an opiate at night.

When the local symptoms and pain are very severe, leeches may be applied to the neck of the tumor, or one of the turgid veins in the scrotum opened. The use of mercury does not appear to be of much value except as a purge.

If the patient, however, from social reasons, objects or is unable to keep at rest, the parts must be well supported by a suspensory bandage; and a very efficient suspensor is formed by a handkerchief folded crossways in a triangle, the apex of which is well braced up posteriorly by a piece of tape or bandage and the base attached firmly to a band brought round the waist (Fig. 422). The same treatment must then be pursued as we have already indicated. A better mode of supporting the testicles is by attaching two loops of tape three or four inches apart to the central portion of the posterior flap of the shirt, and two long tapes to the bottom of the shirt front. On drawing the posterior flap between the legs and looping the front tapes through the posterior loops a most comfortable and efficient support is obtained.

FIG. 422.



The treatment by compression by means of strapping or an india-rubber bag has also been strongly advocated. I have used it but little in the acute affection, although in the more chronic or sub-acute, when the disease has passed into an inactive stage and little remains behind but the *product* of the inflammatory process, the treatment by pressure appears very valuable—indeed, more so than any with which I am acquainted, nothing tending more to hasten the absorption of the inflammatory product (Fig. 426).

Vidal's plan of puncturing the tunica vaginalis, or even the testis itself, has been freely practised by some English surgeons, and Mr. H. Smith speaks highly of its value. I have, however, never seen a case calling for so severe a measure. When tension exists, an incision into the tunica vaginalis may be made with impunity; but I should hesitate to puncture the testicle unless suppuration were present.

If mercury is ever needed in this affection, it is at the chronic stage; as its power doubtless lies in its tendency to produce disintegration of inflammatory products, so it prevents the organization and subsequent contraction of such in and around the spermatic ducts, and thus guards against the special evil effects of epididymitis. When I have had occasion to use it, I have done so as an ointment applied with pressure to the part: but how far the good results which I have had from the practice have been due to the pressure alone I am unable to say. Of late I have been accustomed to employ simple pressure in these cases, and have no reason to believe my success has been less favorable than previously.

If suppuration takes place as a consequence of epididymitis—a result which occasionally happens—it is well to open the abscess early and freely; by such a practice the discharge finds easy vent and the formation of sinuses is prevented. Simple dressing to the part and the use of the suspensory bandage are the best subsequent local means, while tonics and good living are generally required.

Acute Orchitis, or Inflammation of the Seminal Gland.

Orchitis or inflammation of the seminal gland as an *acute* affection, for the most part, occurs as the result of an injury, but it appears at times spontaneously without any such cause, and more particularly in connection with parotiditis or mumps. It may, too, be due to an extension of inflammation from the epididymis or spermatic duct, but it rarely if ever takes place as a primary affection in connection with urethritis or gonorrhœa.

Acute orchitis may also attack the gland in its descent into the scrotum. The following case illustrates this fact: Robert H——, æt. 12, was brought to me at Guy's Hospital on June 20, 1859, and as he walked into the room it was at once observed that his body was bent unusually forward and his movement much restrained. The *right* testicle, not having descended from the abdomen, could not be felt, and the *left* had first shown itself at the external ring three days before the boy's application. Pain in the groin, extended upward toward the loin, had been experienced for two weeks previously. The testicle, which had passed down the canal and partially through the external ring, was about as big as an egg and remarkably tender. The horizontal posture was ordered to be maintained, with the thigh flexed and cold lotion or ice applied. In three days the symptoms had somewhat abated, and at the end of the week the swelling was much less. On July 11, or the twenty-first day after coming under observation, the testicle had passed the external ring, although resting close to it in the scrotum. In another week

all pain had subsided; the testis was free, and the patient disappeared from observation, being quite well.

On August 16, 1871, I saw with Mr. Forman of Stoke Newington a boy æt. 14 with acute inflammation of the left testis, which was at the internal ring. It was accompanied with such severe local and abdominal pain, constipation, and vomiting as to lead Mr. Forman to suspect the presence of a hernia. I saw the patient with these symptoms, and, finding an inflamed painful inguinal swelling the size of an egg, I explored it with a scalpel and discovered a tunica vaginalis filled with pus and a small undeveloped testis. All the symptoms speedily subsided after the operation, and a good recovery ensued.

Symptoms.—The symptoms of acute orchitis are very marked and its diagnosis is easy, for the rapid enlargement of the body of the gland, its flattened oval form and extreme tenderness, are very characteristic. The patient will complain of its weight, and, if standing, will probably assume a bent posture. The disease will be accompanied by extreme local tenderness and pain of a dull aching character, which passes up the loins, round the hips, and often down the thighs. The scrotum will probably manifest some symptoms of inflammation, such as swelling, redness, heat, and increased vascularity. In exceptional examples there will be effusion of fluid into the tunica vaginalis, but this complication is not so common after acute orchitis as after epididymitis, for reasons which have been already given.

The constitutional symptoms will be those of general irritative fever, and will vary according to the susceptibility of the subject of the disease; in some cases they will be very severe, and in others less so.

As a rule, it may also be asserted that acute orchitis tends toward recovery and seldom terminates in suppuration, unless it be of the tubercular form or affecting very cachectic patients. In one known example it ended in gangrene of the part. This case was recorded by the late Mr. Harvey Ludlow in his unpublished Jacksonian prize essay. It was under the care of Mr. Stanley, who was induced to cut into the gland from the severity and obstinate character of the pain, and a black gangrenous cavity was exposed, which was seen after death to have occupied half the organ. I have the records of a case in which the patient stated that one testicle sloughed out after inflammation six months previously: the man came under treatment for inflammation of the other. The termination by suppuration, however, occasionally takes place, and numerous are the examples of this condition which I possess. These cases may also at times end favorably, the abscess healing without any evil result, but too frequently the discharge of the abscess ends in what has been variously described as benign fungus of the testis, granular swelling, or hernia testis. The latter is the most correct and intelligible name, the affection being the result of rupture or ulceration of the tunica albuginea and the gradual extrusion or hernia of the tubuli of the gland, the extruded gland being covered with granulations. The true nature of this affection was first described by Sir W. Lawrence in 1808 (*Edinburgh Med. and Surg. Journal*, vol. iv. p. 257).

Acute orchitis as a consequence of parotiditis, or mumps, is a well-recognized affection, although it may be difficult to explain the connection between the two. It is described by some as a kind of metastasis, but there are no published facts tending to support this view: no one, however, is disposed to deny that the one affection occurs in connection with the other. The disease is not usually very severe: it commonly passes away with little treatment and leaves the testicle sound, few cases being on record of atrophy of the glands attributable to this disease. The symptoms are precisely similar to those already described, and need no further illustration.

Treatment.—The ordinary principles of treatment applicable to local inflammation in general are to be acted on in the treatment of this affection. Rest in the horizontal posture, with elevation of the parts, and cold or warm fomentations according to the relief they afford, are points to be attended to: leeching the groin or local venesection and saline purgatives with sedatives are the chief remedies. The disease has a tendency to get well by itself, and unless badly treated or neglected or attacking very cachectic subjects this will generally be attained. In extremely severe examples, when the inflammation runs high, tartar emetic in full doses is a most valuable drug, while colchicum in half-drachm doses of the wine, with saline purgatives, often acts like a charm. Opium in full doses may also be given where pain is severe and constitutional disturbance great. An acute attack, however, generally runs its course in about ten days, and seldom ends otherwise than well.

Chronic Orchitis.

Chronic inflammation is the most common of the true diseases of the seminal gland, and may follow the acute affection or an injury, but most frequently it is induced by some special constitutional condition, such as gout, tuberculosis, and more particularly syphilis.

Symptoms.—The general symptoms of chronic orchitis, from whatever cause, are much alike, although they differ in some minor but important points. In the syphilitic affection the symptoms are somewhat peculiar, and, as its diagnosis is important, it will receive special consideration. The subject will consequently be divided for consideration into the ordinary forms of chronic orchitis and syphilitic orchitis. Chronic inflammation of the testicle comes on most insidiously, and unless it follows an acute attack is so unmarked by any special symptom and unaccompanied by pain that it is often only by the increased size of the gland that the patient is induced to seek advice. In some cases, however, this swelling is accompanied by pain of a dull and aching character. In the early stage of the disease the gland may be more or less painful on manipulation, but in a more advanced condition or in a very chronic case no local pain will be experienced even on somewhat rough manipulation; and in these examples, on firm pressure, the ordinary testicular sensation will fail to be excited. The general appearance also of the testicle the subject of this affection is somewhat peculiar. It is not pyriform or globular, as in hydrocele and many other affections of the gland, but has a peculiar flattened outline from side to side, and a smooth, even surface, unless the disease be associated with some effusion into the tunica vaginalis, when the tumor will naturally assume more the shape of a vaginal hydrocele. But the simple affection is rarely associated with such a complication; and when it is, the fluid, as a rule, is secreted in very small quantities. The epididymis, in exceptional examples, from the extension of the inflammation to its tissue, may be slightly enlarged and thickened; but this never occurs to any great extent.

There are also seldom any constitutional symptoms worthy of remark, except in cachectic and irritable patients, when the dull aching pain of the part may give rise to some general irritability of the patient's condition and an anxious expression of countenance.

Pathology.—The pathology of this affection is that of chronic inflammation of any other part, and consists in a more or less general infiltration of the gland with an organizable or organized material, the inflammatory effusion separating the secreting tubuli and affecting them in ways determined by the amount of fibrin poured out between them and the amount of pressure to which they are subjected, the inflammatory product in some cases being very generally diffused between the tubuli, while in others it is deposited in irregular masses. When the material poured out is very great and equally diffused between the meshes of the testis—*i. e.*, when the disease is extensive or of long standing—that condition of the gland is probably produced which is indicated by an utter absence of the natural sensation of the organ on handling or on firm pressure, and under such circumstances there is the greatest anxiety for the subsequent maintenance of the integrity of the organ, though, should the disease make a favorable progress toward recovery and the inflammatory product be reabsorbed, the pressure will be proportionately removed from the delicate tubuli of the organ and the natural testicular sensation be restored.

If the inflammatory product soften down, as it will in the delicate and cachectic subject, suppuration will take place; and in proportion to its extent will be the liability to a *hernia testis*.

Again, should this inflammatory product proceed to a more permanent organization and contract, the delicate tubuli of the testicle will suffer in proportion to the extent of the part involved, and an atrophy of the organ be the result as a consequence.

All these complications are met with in various degrees in practice, and with greater or less frequency, the general condition of the patient having a more important influence in determining the result even than the treatment; but I may add that there are few affections which are more amenable to good treatment than that now under consideration.

When the disease is remarkably insidious in its advance, slow in its progress, and painless in its character; when the patient is cachectic and irritable, with an anxious countenance, a disposition to a hot skin, and to other symptoms of constitutional irritation; and, more particularly, when the disease ends in suppuration, as in all probability it may when coming on and progressing in the manner just indicated,—it is reasonable to believe that the organ is the seat of *tubercular mischief*, and that it disorganizes as a result. It must be added, too, that in these cases the tubercular affection is probably of

the infiltrating or miliary tubercular form, and not of that crude nature which runs a different course, and to which attention will subsequently be directed.

In gouty inflammation of the organ the symptoms, as a rule, are not so chronic as in the class of cases to which we have just alluded. Indeed, they may more rationally be described as being of a subacute nature; for, though generally coming on slowly, they are manifested by greater local tenderness and pain, the pain being considerably aggravated at certain periods, and most probably at night. The disease has, moreover, a strong tendency toward recovery, and not toward disorganization of the testis. Besides these symptoms, others indicating a gouty disposition will probably be present, such as acidity of stomach, a loaded condition of the urine, and a more or less distinct history of gout. There will also be frequent nocturnal pains of a darting character in the opposite testicle, leading the patient to fear—what is by no means rare—a double attack; and when these pains occur, they are valuable in connection with others as diagnostic symptoms.

Symptoms and Diagnosis of Syphilitic Orchitis.

That syphilitic inflammatory disease may attack the testicle as any other gland or texture within or without the body is at the present day a well-recognized pathological fact, and the credit of establishing this position is largely due to my colleague, Dr. Wilks. In what way the syphilitic differs from other forms of inflammation is a point worthy of consideration, and, fortunately, the points of difference are neither numerous nor deeply seated. The main one is palpable and apparent, for even by the most casual observer it is readily seen that in syphilitic inflammations there is not only an infiltration of the part affected with an organizable or organized material of a dense, firm, and fibrous structure, but a marked tendency of the deposit to undergo fibrous changes. We see this in every tissue and in every stage of the disease. We see it primarily in the almost cartilaginous hardness of the base of the true infecting chancre; we see it in the early constitutional symptoms of syphilis and in the greater permanency of skin-staining in the different eruptions; in the different affections of the mucous membranes in all their parts; in the inflammation of the eye, cellular tissue, periosteum, and bone. The pathologist sees it, moreover, in the varied changes found after death in the internal organs of the syphilitic subject, and the surgeon sees it, likewise, in the inflammation of the testes; for in the subject of hereditary or acquired syphilis the testicle may at some period of the disease—and generally at a late one—become the seat of a syphilitic inflammation which manifests all the peculiarities of this pathological condition. The affection is essentially chronic—as much so as the other forms of chronic orchitis—but is almost invariably confined to the body of the gland, and rarely affects the spermatic duct. It is quite painless in its nature, local and general, the patient bearing free manipulation without flinching and often thinking little about his disease except from the increased size of the organ. The special sensation of the gland usually disappears at a very early stage of the disease, and there is rarely any constitutional disturbance accompanying its progress. It may or may not be associated with other symptoms of constitutional syphilis, but usually appears alone.

The disease manifests itself locally in a special manner which claims attention. It usually affects the body of the testis and both testes at different periods of its progress, though rarely at the same time. It is almost always complicated by the presence of a vaginal hydrocele, which at times increases to a considerable size, and much more so than in other forms of chronic orchitis. The most characteristic point of all, however, is the remarkable stony induration of the gland and its peculiar, irregular, nodular outline, small fibrous projections from the body of the gland being distinctly visible in some cases, while in others loose bodies are felt in the tunica vaginalis.

Prognosis.—In the majority of cases this disease terminates by resolution and apparently leaves the gland intact, although in many a gradual wasting of the testicle is the result, which ends in atrophy, and, as a consequence, in sterility. In exceptional cases suppuration with or without hernia testis may take place. The disease, too, when apparently cured, has a remarkable disposition to return on the slightest provocation.

Treatment.—There are few affections more amenable to treatment than chronic orchitis, especially when taken early, and there are none which better prove the value of pressure and mercurials in procuring the absorption and disintegration of inflammatory products. In the common as well as in the syphilitic orchitis this statement holds good. In a healthy subject with good powers and an unbroken constitution any form of mer-

curial may be administered, such as blue pill in four-grain doses or the perchloride, or mercurial inunction with the oleate of mercury is likewise beneficial. The object of the surgeon is neither to salivate nor to bring the patient rapidly under the influence of the remedy, but rather to procure a lengthened and equal action of the drug upon the local disease; the dose, therefore, should be carefully regulated. In my hands the iodide of mercury given in one-grain doses, with five grains of Dover's powder twice a day, or the mercurial suppository, has proved eminently beneficial, the testicle being well strapped up by common soap plaster. (See Fig. 426.) In a more cachectic patient in whom mercury may still be tolerated the same treatment may be employed, though in smaller doses; and in others the mercurial may be locally applied in the form of an ointment, or as an oleate dissolved in oleic acid in the proportion of five per cent. During this time tonics such as quinine and iron may be administered and good living and fresh air enjoined.

In certain examples, however, occurring in cachectic patients it may not be desirable to administer mercurials in any shape; under such circumstances iodine may be substituted in the form of the iodide of potassium in three- or four-grain doses, gradually increased to ten or twelve, combined with half-drachm doses of the syrup of the iodide of iron in infusion of quassia, three times a day. Locally, strapping—or, rather, pressure—should still be enforced. In hospital practice this treatment has been of great value; by it, steadily persevered in for six or eight weeks, even the worst of cases may be expected to yield, the organ gradually becoming softer and more natural in sensation and shape, and at last resuming its normal condition.

In the *gouty* form of orchitis, which can be recognized or suspected by the symptoms already quoted, the administration of colchicum is very beneficial. It should be given in small doses and continued for several weeks. The acetic extract in half-grain doses, with Dover's powder, is the best form; and with it a cure may generally be guaranteed. This form of disease is easily reduced when early recognized. It is more liable, however, than other forms to relapses, but less so to disorganization and subsequent atrophy.

If there be sudden accessions of pain in the part, with other evidences of some fresh inflammatory attack, the application of a few leeches with hot fomentations is very serviceable; but these conditions are uncommon.

When vaginal hydrocele coexists with the inflamed gland—a frequent complication of the syphilitic variety—it is a good practice to draw off the fluid, to enable the surgeon to apply his pressure with more certainty and better effect. It is of no use to attempt to cure the hydrocele itself, as it must be remembered that the hydrocele is the direct consequence of the diseased testis, and that it is of little use to treat the effect of a diseased condition and not its cause. Remove the latter, and the former will probably disappear; cure the orchitis, and the hydrocele will generally depart.

I have the records of a case which passed under my care for treatment where by some oversight this attempt had been made, and the hydrocele was tapped and injected with iodine on three different occasions without success. Under the subsequent treatment the chronic orchitis disappeared, and with it the hydrocele.

It is not always desirable, nor is it possible in a large proportion of cases, to keep the patient absolutely at rest during the process of treatment. In some it is advisable to do so as much as possible, particularly when the patient experiences more pain and inconvenience when walking or moving about, but in the majority of cases it is sufficient to keep the parts well supported.

In the consideration of the treatment of chronic orchitis it has been stated that a good recovery may generally be secured by the means which have been suggested when the disease has been taken in hand at an early period of its existence—that is, when not more than five or six weeks have been allowed to elapse. But in cases of longer standing the prognosis is not so favorable, as regards either the removal of the disease or the subsequent integrity of the part as a seminal gland. These remarks apply more particularly to the syphilitic form of the affection, for if of long standing the fibrinous matter has generally become too well organized for future absorption; and when this is the case the subsequent contraction of the organized product will almost to a certainty go on to the destruction of the seminiferous tubuli and an atrophy of the gland. In Guy's Hospital Museum are several admirable specimens exhibiting this result.

Again, in certain examples of chronic orchitis, whether syphilitic or otherwise, suppuration and disintegration of the gland structure will take place. This termination may be suspected when the disease is of a very torpid character, the pain of a constant aching kind, and when all treatment fails to influence its course.

When pus has formed, its early evacuation is the best practice, as a clean incision or puncture into the part often prevents that destruction of the glandular structure and its fibrous covering which usually precedes that troublesome affection, hernia testis.

Tubercular Disease of the Testicle.

Tubercular disease of the testicle may attack any part of the organ—that is, either the seminal gland or its duct, or it may affect these parts separately or together. It may show itself either in the form of an infiltration of the so-called miliary tubercles or in the more distinct and usual condition of the yellow, cheesy, unorganizable material described as crude tubercle. When it appears in the form of miliary tubercle, it is not characterized by any very definite symptoms; indeed, the infiltration of a gland with those small gray miliary bodies seldom makes itself known by any outward visible signs, and their presence should be suspected only when a rapid disorganization of the part takes place after an attack of acute or chronic inflammation. Organs thus infiltrated have no power of resisting the inflammatory process, and, whether it be a lung or a testicle which is the seat of this affection, active breaking up of tissue with suppuration generally ensues. I shall exclude from present consideration those interesting cases, remembering that, while pathologically they are clearly to be recognized, practically their presence can be suspected only when the result to which I have already alluded takes place.

Symptoms.—The other form of tubercular testis is characterized by more special symptoms and local conditions. It may involve, as already stated, either the body of the gland or the epididymis, but doubtless the latter is the more frequently diseased. It is generally discovered accidentally by the patient, and frequently not until some secondary change in the structure is about to show itself. It appears primarily as an indolent, painless enlargement of the epididymis and is usually described by the patient as a lump in the testicle, this lump appearing generally at the upper part. This symptom, in all probability, is the only one to which attention can be drawn; and the surgeon will recognize it at once on manipulation, for the tubercular matter will feel as if some foreign body, as a pea, bean, or nut, had been placed between the convolutions of the epididymis or in the substance of the gland. The gland is not painful on pressure, nor in its inactive stage does the disease seem to cause any injurious influence on the organ, which is otherwise natural in its sensation and function.

In other cases the disease will appear as a general infiltration of the part involved; and should this be the epididymis, it will be enlarged, indurated, and nodular—painless, perhaps, and inactive, the body of the testis, apparently sound, resting on the concavity of the affected portion. If the body of the gland be the part affected, like symptoms will be present, although the enlargement will show itself as a uniform or nodulated expansion of the secreting structure, the epididymis or seminal duct being quite distinct.

This inactivity of the disease, however, does not always remain, though it may last months, or even years; but the time will come when the tubercular matter, in all probability, will soften down, and thus excite some increased action in the parts around. It may be that this increased action in the part will first draw the patient's attention to his affection, when the history of some previous thickening of the organ will for the first time be obtained. When inflammatory symptoms are once developed, the disease will certainly make rapid progress, and disintegration of this unorganizable tubercular matter accompanied by suppuration will speedily follow.

In tubercular epididymitis—for such this disease may be named—local suppuration will soon appear, with the discharge of ill-formed pus and *débris* as a curdy, friable, and granular material, and after this sinuses are apt to form, which may go on discharging for a period depending on the extent of the disease and the amount of foreign material existing to disintegrate and soften.

If the body of the testicle be the part implicated, the same gradual softening and suppuration will take place; but too often it will be followed by the formation of the hernia testis, to which allusion has been already made. It is not, moreover, in every case of this disease of the testis that disintegration of the tubercular material is to be expected, with its accompanying suppuration and abscess; for in many examples no such result can be found, this tubercular matter undergoing a gradual change and showing itself after death as an earthy concretion. The same changes take place in the testicle as is seen in the absorbent glands, the lungs, and other parts.

Tubercular disease of the testis may occur at any age, but is more common in adult life. The best example that I have seen was in a child aged two years whose testicle I excised for disease of six months' standing, which had progressed very slowly and acquired a large size before suppuration occurred. Convalescence followed the operation (Fig. 423). The whole organ, with the epididymis, was nearly filled with scrofulous deposit. It is in the testicle that we have the best opportunity of examining the true tubercular disease in its different stages, and of watching the various form of its deposition, its changes, and decay.

FIG. 423.

Hernia of the Testicle following Tubercular Disease. (Removed from infant æt. 2.)

TREATMENT.—When tubercular material has been once deposited in the testicle, as in any other tissue, there are no recognized means by which the absorption of this material can be procured. It is true that it may remain in an inactive or passive condition for an indefinite period, and finally, by undergoing an earthy degeneration, cease to trouble; nevertheless, it will still exist, ready, as it were, on the least disturbance to light up some inflammatory action in the tissues around and to give rise to any or all of the various conditions just described.

Looking also upon the deposition of turbecle in a testicle as only one of the local manifestations of that general condition described as tuberculosis, it is clear that the principles of treatment should be of a general character to improve the health and revive the powers of the patient by tonics, good living, good air, regular habits, and—what is of great importance—total abstinence from sexual excitement or gratification. Indeed, the parts should be maintained as much as possible in a quiet condition, and for this purpose cold sponging night and morning is of some service.

When inflammatory symptoms make their appearance, they will generally run their course, in spite of treatment, for, as already shown, they are usually caused by the breaking down of the tubercular deposit, which may be looked upon as one of nature's means for its elimination; indeed, until this material has been discharged the subsidence of inflammatory symptoms is not usually to be expected; fomentations in this stage and the application of water dressing to the part are, therefore, suitable, and the testes should be supported in a suspensory bandage. When suppuration is nigh at hand or has manifested itself, it is good practice to open the abscess freely with a lancet, as it saves time and pain to the patient and often prevents the formation of the sinuses which prove so troublesome. During all this time the health of the patient must be attended to by ordinary measures.

When the gland has attained a large size and is evidently destroyed by abscesses and disintegration of the infiltrating material, it may be excised, and more particularly if hernia testis has appeared and the disorganized testis is a source of trouble and weakness to an enfeebled patient.

HERNIA TESTIS.

This affection, which has been variously described as "granular swelling" and "benign fungus of the testis," has also more correctly been called "hernia testis," for it is essentially a gradual protrusion of the substance of the gland through a rupture or ulceration of its fibrous envelope, the tunica albuginea. It may follow upon suppuration of the body of the gland the result of an injury or of an acute or chronic orchitis, or from the softening down of tubercular deposit. It seems to be the result of pressure produced by the natural elasticity of the fibrous tunica albuginea, the testicle, as it were, being gradually squeezed out of its capsule and everted, the mass being eventually increased by the free granulations which spring up on its surface. The whole organ or only a portion of it may thus be extruded from its natural position, the extent varying according to the amount of disease and the size of the opening in the tunica albuginea and integuments. It must not be supposed, however, that this hernia testis is the necessary consequence of suppuration or of disorganization of any portion of the gland, for such is not the case; indeed, in the majority of instances of suppuration it does not occur.

DIAGNOSIS.—The diagnosis is not difficult, and the disease, having been once seen,

can be subsequently readily recognized. It is a peculiar fungating-looking growth with everted edges and a sinus in its centre, generally secreting pus. It is of variable extent and presents a more or less irregular surface and a pedunculated base, the pedicle passing through an opening in the scrotum to the remains of the testicle. The margin of the opening in the scrotum is generally free, although in some cases adherent to the growth. It may be slightly indurated, from inflammatory thickening, but will never present the same aspect as a cancerous growth, for which, however, this affection may be mistaken, the term "fungous testis" having doubtless been the means of encouraging the great error of regarding this simple disease as malignant. The natural sensation of the gland remains, however, in these cases, and will be readily excited by manipulation, whereas in cancerous disease no such natural sensation exists; in doubtful cases this point is one of primary importance.

Treatment.—It may safely be stated that the majority of cases of hernia testis can be successfully treated by other less severe measures than castration, although this operation has been very generally performed for this affection. In exceptional instances it may be demanded, and I have the records of many in which it has been successfully performed. The surgeon's object, it may be briefly stated, is to restore the extruded testicle to its natural place, which may frequently be done by simple pressure applied by fixing a good firm pad over the surface of the growth and drawing the margin of the ulcerated scrotum well forward, fixing the whole in position by strapping. In other cases, where the granulations are very exuberant, caustics may be used to hasten their destruction; among the best is the red oxide of mercury; pressure should be well maintained during its use. All minor cases, and many of the severe, may certainly be cured by these means if steadily pursued and well applied. In the more obstinate and severe examples other measures must be adopted. The excision of the surface of the growth was formerly employed, and is occasionally resorted to in the present day, but at best the practice is a very doubtful one, for in the majority of cases to which it is applicable it would be tantamount to castration, as the fungating mass is, as a rule, composed of the everted tubules of the testis, covered with granulations, and consequently by this measure the tubules would be cut off and the gland destroyed.

Mr. Syme described in the *London and Edinburgh Monthly Journal* for January, 1845, a plan of treatment which in these cases is very serviceable. The operation consists in the elevation of the margin of the scrotum from the protruding mass, the reduction of the hernia testis within the scrotum, and the retention of the part in its natural position by stitching together the margins of the wound, careful bandaging and strapping being also required in the treatment of these cases. The granulating organ becomes attached to the inner surface of the scrotum, and a healthy action is subsequently restored. It is almost needless to add that a local and constitutional treatment for the original affection of the testis should at the same time be maintained.

Cystic Disease of the Testicle.

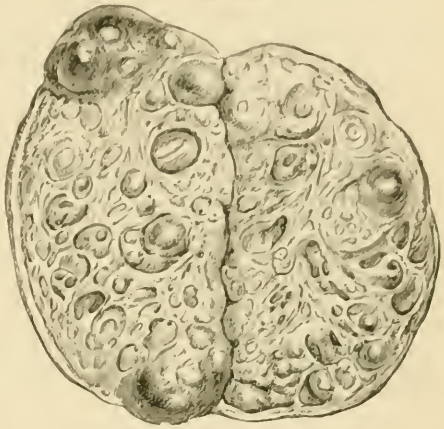
There is no affection of the testicle on the nature of which there has been a greater difference of opinion than cystic disease, and, although modern pathologists have devoted considerable attention to its investigation, the subject has not yet been brought out of its obscurity and made plain to the profession.

Sir A. Cooper, one of its original inquirers, looked upon it as a distinct disease of the secreting *tubuli* of the organ, and upon his authority this view was for a time generally received. More recently Mr. Curling's researches have tended to prove it to be an affection of the *ducts* of the testicle, and not of its secreting tubuli. "Why they alone," says Mr. Curling, "are subject to the morbid change I admit my inability to explain." Whether this opinion be correct or not will be one of the subjects for present consideration, since I am disposed to think that it is not quite consistent with observed facts, although there can be no doubt that the rete testis appears to be the seat of the disease in certain cases, while in exceptional examples cystic disease is undoubtedly formed independent of this structure.

It has been my privilege to examine many examples of this rare affection with some care, and I entirely concur in the main with Mr. Curling's conclusions, although I am not so sure of the special seat of the disease as he appears to be. It is doubtless made up of cysts, which are multilocular and of sizes varying from that of a mustard-seed to a moderate-sized nut (Fig. 424). These cysts are filled with a thin, serous, blood-stained, or glairy fluid, and at times with more or less pedunculated intracystic growths made up

of a delicate cellular structure or of a distinct cell tissue. These cysts appear imbedded in a fibrous stroma of different degrees of consistency and density. The fibrous elements in some are much more numerous than they are in others, whilst in some, again, it will be of a more delicate nature and more allied to the fibre structure found in the softer sarcomatous growths of other parts. In certain examples the cysts are clearly made up of dilated tubes with pouches at their extremities or as lateral dilatations, these tubes containing granular matter being occasionally lined, as Mr. Curling was the first to observe, with tessellated epithelium. I have failed, however, to find this in all the cases I have examined, and am disposed to look upon the presence of this tessellated epithelium as specially characterizing a certain growth. Spermatozoa are invariably absent in the cysts or tubes of this affection, while cartilage or bone elements will almost always be found to exist, either as small isolated patches or as filling the cyst, in which case the growth might be described as an enchondromatous tumor; the cartilage is deposited in separate masses, and these masses are divided by a fibrous stroma. The true secreting portion of the testicle will often be found pushed up into some corner of the tumor, spread out over the cystic mass, or distributed between the cysts themselves, the tumor being invariably encysted in its own capsule; in rare cases tumors of this nature will be found upon the cord and body of the testicle. The above facts lead me to conclude that the majority of these are new growths following the great law which governs the development of all tumors by taking on the likeness of the part in which they are developed, and that they are more or less built up as is the stricture of the normal gland. The testis being essentially a tubular organ, all morbid growths developed in or near it have a tendency to assume a tubular or cystic character, this character varying in extent in different cases, the cystic or tubular and fibrous or sarcomatous structure being found in different degrees of perfection and quantity in different cases.

FIG. 424.



Cystic Disease of the Testicle

We may thus find in the testicle a tumor presenting all the elements of the fibrous or sarcomatous tumor without cysts, whilst in another, in which the cystic formation more or less predominates, the same elements will exist in smaller proportions; and in the majority of these examples the true structure of the testicle will be found spread out in a variable extent over the special capsule of the new growth. In other cases the new growth will be altogether free from any connection with the testis itself and be found growing from the cord. All these separate kinds of tumors, examples of which may be seen in Guy's Museum, appear to me merely modifications of one kind of growth, the simple—or, perhaps more correctly, adenoid—growth of the testis.

We thus see a close analogy between these tumors of the testis and those of the mammary gland, as well as of the ovary, and find in all the simple adenoid tumor partaking more or less of the nature of the gland in which it is developed, and a true cystic disease of the gland itself, the latter being evidently a special affection of the tubes and ducts of the mammary gland or testis, and not of the secreting structure. In both organs they are new growths simulating more or less correctly the anatomical structure of the true gland.

SYMPTOMS AND DIAGNOSIS.—Having described the special pathology of this disease, I pass on to consider its clinical aspect, as well as to point out the symptoms which indicate its presence and help the formation of a correct diagnosis. In doing so I must premise that the several forms of this cystic disease are to be recognized more by negative than by positive signs, since they appear usually as painless enlargements of the organ, are of slow growth, and are unaccompanied by any such symptoms as attract attention, the patient, indeed, seldom seeking advice until the organ has become troublesome from its size, or the dragging pain in the loin, which always exists when the testicle has become large and heavy from any cause, excites anxiety. The testis soon loses its natural shape and assumes more the oval or pyriform outline of a vaginal hydrocele or hæmatocele. It will probably have a smooth and equal surface and be indistinctly fluctuating, though not translucent, while its natural sensation, experienced on manipulation, will most likely

have disappeared at a very early stage of the disease. The general health of the patient may probably be good, and there will be no evidence of any secondary glandular affection

From hydrocele and hæmatocele the disease may generally be recognized by the history of the case, the opacity of the tumor, and the loss of the natural testicular sensation. When doubt exists, an exploratory puncture by the trocar and canula will decide the point; for in cystic disease a little bloody and glairy fluid will alone escape.

From the inflammatory affections it may be diagnosed by the difference in the shape and feel of the tumor, the flattened compressed form of the organ, with its hard and nodulated feel, as met with in the different forms of orchitis, contrasting with the more or less globular or pyriform shape, smooth outline, and elastic feel, without the peculiar testicular sensation present in cystic disease. The inflammatory affections are also often associated with a hydrocele; the cystic, rarely. In the former, also, both organs are generally affected sooner or later, while in the latter the disease attacks only one. Medical treatment does not appear to have any influence in arresting the development of the cystic, whilst in the inflammatory disease a good recovery may generally be secured by the use of proper remedies.

Treatment.—There is but one remedy, which is the removal of the diseased organ. No drugs seem to have the slightest effect in diminishing its size or arresting its growth. Excision, therefore, should be performed, the operation being, as a rule, most successful.

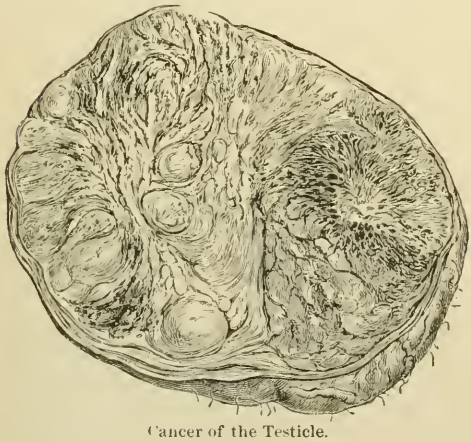
Cancer of the Testicle.

The testicle, like all glands, may become the seat of cancerous disease, both of the carcinoma fibrosum, or hard cancer, and of the carcinoma medullare, or soft cancer. It is rare, however, for the hard cancer to attack the testis, the majority of examples being of the soft or encephaloid form. For one example of the hard cancer it is probable that at least twenty of the soft are met with in practice. In the different museums specimens of the former kind may be seen, and at Guy's several exist.

Cancer may also attack this organ in one of two forms, either as the tuberous or as the infiltrating cancer. In the former the disease appears either as an isolated growth or as several distinct tumors separating the parts and then eventually coalescing into one mass; in the latter it appears from the beginning as the infiltrating kind, the cancerous elements being more equally distributed between the tubes and ducts of the true secreting gland tissue.

The malignant affections of the organ, as the simple, are accompanied by the development of cysts, and these, in the malignant cases, are filled with cancerous matter in lieu of the glairy mucous or fibro-cellular intracystic growths which are found in the sarcomatous, adenoid, or cystic diseases. In rare examples both conditions seem to coexist in the same organ, simple cysts, with the clear or blood-stained glairy fluid, being found in one portion, whilst in others these cysts are filled with cancerous material, and in a third enchondromatous masses may at times be present (Fig. 425).

Fig. 425.



Cancer of the Testicle.

The part of the organ generally attacked is the body of the gland, although the epididymis may be the seat of the disease; but when the latter is involved, as a rule it is an extension of the disease from the body of the tumor. Rare examples, however, exist which illustrate a primary affection of the epididymis.

Cancer may attack the testis of the old as well as of the young, and I have the records of cases occurring in men aged fifty-six and sixty-two respectively. Instances of this disease attacking infants even so young as seven months have likewise been recorded by different authors, and I have excised a cancerous testicle from a boy only two years old. The majority of cases occur, however, in young adult life, from twenty-five to forty years of age, as is indicated by the following facts.

I possess the records of twenty-five cases, which I have added below to the fifty-one

examples originally tabulated by Mr. Harvey Ludlow in his Jacksonian prize essay. The results are as follows:

Before the age of 5	6 cases.
From 15 to 20 years	2 "
" 22 to 30 "	17 "
" 31 to 40 "	31 "
" 41 to 50 "	11 "
" 51 to 70 "	9 "
Total	76

Out of my 25 cases the disease in 20 had been growing for one year or less, and in the remaining 5 cases 2 were of three years', 2 of four years', and 1 of five years' standing.

It is rare, if not unknown, for both testicles to be the seat of cancer at the same time. I am not aware of any such example being on record. In 16 out of the 25 cases before me the right organ was attacked, and in 9 the left. Malplaced testicles appear to be particularly prone to this disease.

Cancer of the testicle may come on as insidiously as the simple cystic disease, but in general its growth is more rapid. It makes its appearance as a gradual enlargement of the body of the organ, seldom attended by pain. There is also an early loss on pressure or manipulation of the special testicular sensation. The outline of the tumor is smooth, semi-elastic, and fluctuating, but as the disease progresses its surface may become somewhat uneven or irregularly bossy, the tumor being harder in some parts than in others, the softer parts projecting. In the carcinoma fibrosum, however, the whole tumor is hard and at times nodular. The tumor is opaque from the beginning, and rarely, if ever, associated with hydrocele; and when it is so, it is by chance, the one affection having no direct relation to the other. In this respect cancer differs from inflammation of the organ, which is very frequently complicated by the presence of hydrocele.

The disease rarely extends beyond its fibrous covering or involves the scrotum, and for a bleeding fungus to form the tumor must be very large. As the disease progresses the health of the patient may suffer and a general aspect indicative of exhaustion and some wasting disease appear, although it is not till a late period of this affection that any such symptoms are to be expected. When lumbar pain or a constant aching exists, a suspicion of enlarged lumbar glands should be excited, and in certain examples a chain of enlarged glands may be felt extending upward along the psoas muscle.

The inguinal glands are occasionally enlarged from infiltration, though it is believed by some that this complication does not appear till the scrotum is involved in the disease. This, however, is certainly not the case, for large inguinal glands may appear at an early stage of the affection.

Diagnosis.—The diagnosis of this disease is by no means easy, particularly in its early stage; indeed, in many instances it is almost impossible to be certain of its nature. It is the size of the organ which generally first draws the attention of the patient to the part, and the pain and inconvenience caused by its weight which prompt him to seek advice.

The history of the case and the absence of translucency will prevent its being mistaken for a hydrocele. Hæmatocele, as a rule, has a distinct and special history of its own, and the fact that the testis may be made out to exist in some portion of the tumor is a material aid to the surgeon in forming a correct opinion as to the nature of the case.

The tenderness of the organ, the nature of the pain, and the shape of the swelling are sufficient to indicate the inflammatory affection; and when fluid exists the diagnosis is rendered more plain, since a vaginal hydrocele rarely coexists with any other disease than the inflammatory, except to a very slight extent.

The simple cystic disease is of slower growth than the cancerous, and generally firmer to the feel; when punctured, it yields also a glairy fluid unlike the creamy material which comes away from the cancerous disease. The subject of diagnosis of all these growths will, however, be discussed hereafter.

Treatment.—The only treatment which gives any comfort to the patient is excision of the organ, and this should be done as early as the diagnosis can be made, for there is then less chance of the glands in the loin becoming involved. The general health must also be attended to with great care at the same time.

Diagnosis of Scrotal Tumors.

I propose now to consider the subject of the diagnosis of scrotal tumors as a whole, to describe the train of thought which passes through the surgeon's mind when examining

Table of Diagnosis of Chronic

Symptoms.	Hydrocele.	Hæmatocele.	Chronic orchitis.
Condition of tumor.	Tense, usually transparent, fluctuating.	Tense and elastic; *not* transparent; *obscure* fluctuation.	Firm, and not elastic; *not* transparent; not fluctuating unless complicated with hydrocele.
Outline.	Smooth and uniform.	Smooth and uniform.	Smooth and compressed laterally.
Position of testis.	Posteriorly in *vaginal;* anteriorly at side or below in *encysted.*	Posteriorly.	Evidently an enlarged testis.
Testicular sensation.	Present on manipulation.	Present on manipulation.	Present at first; absent after long existence of disease.
Rapidity of growth.	Gradual; most so in *encysted.*	As a rule sudden, and after accident at times spontaneous and gradual.	Slow.
Size.	To great dimensions in *vaginal;* moderate in *encysted.*	Moderate.	Rarely more than three or four times natural size.
Form.	Pyriform or oval in *vaginal;* globular in *encysted.*	Pyriform or oval.	Oval, with flattened sides.
Pain.	Very slight, if any, except when complicated with inflamed testis, and in acute hydrocele. Not increased on pressure.	Painful at first and at a later stage; not so during the intermediate.	Dull pain, increased on pressure, except in very chronic disease.
Manipular indications.	Like fluid, vibration on palpation.	Firm and solid.	Firm and solid unless associated with hydrocele.
Seat of its commencement.	In *vaginal,* at the lower part of the tumor; in *encysted,* at the upper.	.....	Evidently in body of gland.
Cause.	No recognized cause.	An injury or strain; rarely spontaneous.	Injury, or idiopathic.
Progress.	Has a tendency to remain tranquil, and not to inflame unless injured.	Has tendency to inflame and suppurate, and not to remain tranquil for long.	Slow growth; rarely, but at times, ends in suppuration.
Condition of cord.	Free and healthy.	Healthy.	Often full and tender on manipulation.
Results of tapping, exploratory or otherwise.	Straw-colored, serous fluid in *vaginal;* limpid, opalescent in *encysted.*	Blood fresh or broken up with pus.	.....
Condition of inguinal and abdominal glands.	Free and healthy.	Healthy.	Healthy.
Complications.	Inflamed testicle.	None, unless hydrocele or injured testicle.	Occasionally with hydrocele.
Organs involved.	Occasionally double.	Never double.	Generally both organs, either separately or together.

Disease of the Testicles.

Syphilitic orchitis.	Tubercular disease.	Cystic or adenoid disease.	Carcinomatous disease.
Very solid, but not elastic or transparent unless complicated with hydrocele, which is very general.	Indolent indurations in body of gland or epididymis, like foreign bodies. Toward the end these bodies soften and excite suppuration.	Firm and elastic; insidious enlargement of gland; not translucent; indistinct fluctuation.	A tense and firm enlargement of body of testis; not translucent. Indistinct fluctuation toward later stage; bossy outline; parts softer than others.
Irregularly nodular and very hard.	The epididymis the most frequently involved.	Generally regular, smooth, and elastic; rarely bossy.	
In tumor.	In natural position, often half surrounded by epididymis as a half crescent.	In tumor.	In tumor.
Absent altogether, except in the very early stage; returns also toward convalescence.	Present.	Present at first, but soon lost.	Soon disappears.
Slow in the extreme, often hardly noticed.	Slow at first; rapid afterward, when softening and inflamed.	*Unequal;* slow at first, more rapid afterward.	Rapid, as a rule; slow only in the carcinoma fibrosum, which is very rare.
Moderate.	Moderate.	Rarely, but sometimes, very large.	Sometimes very rare.
Irregularly oval and lumpy.	Lumpy; uneven in all its stages.	Oval, with flattened sides. Smooth at first, subsequently bossy.	Globular or pyriform. Smooth at first, subsequently lumpy, softest at these points.
Very slight; allows rough handling. Toward end of disease, on recovery, pain on pressure returns.	Very slight pain or tenderness, except when pressed hard or inflamed.	Slight when present; generally painless, even on manipulation.	Very slight, even on free manipulation.
Very hard and irregular outline. Often hydrocele, with small fibrous bodies in tunica albuginea.	At *first* as if foreign bodies existed in the parts, lumpy; at *last* soft before suppuration.	Firm and elastic, more so in one spot than another.	Firm, but elastic; softer on the bosses, when present.
Always in body of gland.	Generally in epididymis; occasionally in body of gland.	In body of gland.	Body of gland.
Constitutional syphilis, hereditary or acquired.	Tuberculosis.	Unknown.	Unknown; occasionally from injury.
Essentially chronic; rarely terminates by suppuration.	Very indolent and insidious; tends to inflame and suppurate after an uncertain period.	Unequal; never inflamed.	Rapid as a rule; rarely slow.
Free.	Healthy.	Healthy.	Full; veins enlarged.
.....	.....	*Mucoid fluid*, more or less blood-stained.	*Blood or creamy fluid*, with characteristic cell-growth on microscopical examination.
Generally indurated.	Generally indurated.	Rarely involved.	Generally involved.
Hydrocele, almost always. Other syphilitic affections.	Rarely with hydrocele. Tubercular disease in other parts of body.	Rarely with hydrocele.	Cancer in other parts; rarely with hydrocele.
Often both organs.	Both organs, as a rule, involved.	Always single.	Single as a rule.

such a case with diagnostic intentions, and to point out the special symptoms or their combination as they tend to indicate the presence of any special affection. In doing this I believe that a near approximation to truth may generally be made when the history of the case and its special symptoms are carefully weighed. Great difficulty may occasionally be experienced in any given case, or it may be beyond our power to form any positive opinion upon its nature; but I am not disposed on that account to place among impossibilities the diagnosis of a scrotal tumor. There are gradations of probability in all our conclusions as to the diagnosis of any disease, and a certainty untainted by fallacy or doubt is rarely obtained, but I take it we are as often correct in our judgment of a scrotal tumor as of any other affection. To aid the student in this task the table on pages 746, 747 has been drawn up.

The first point the surgeon has to decide on being consulted as to the nature of a scrotal tumor has reference to the question of hernia. Is the tumor connected with the testicle, or has it passed down the direction of the cord from the abdominal cavity? If the surgeon is able to isolate the growth at its neck from the abdominal cavity by the thumb and finger, the question is at once decided; for almost all scrotal tumors can be so isolated, it being quite exceptional for any to pass up the cord so far as the internal ring. Rare cases of vaginal hydrocele or hæmatocele, however, in which the tunica vaginalis is open up to the internal ring, form an exception.

It being determined that the swelling is not a hernia, the nature of the tumor next claims attention.

Is it a hydrocele or hæmatocele? Is it the product of inflammation or of tubercular disease? Is it a new growth altogether? and if so, is it innocent or malignant in its nature?

If the tumor prove translucent by transmitted light, the existence of a hydrocele is fairly decided; but, then, is it an ordinary vaginal hydrocele or encysted? Should the tumor be large, even, and pyriform, and the testis be found at the posterior part of the tumor, either by means of manipulation or by the opacity displayed at one spot on transmitting light, vaginal hydrocele may be suspected; but should the testis exist in front or at one side and the tumor have been of very slow growth, small, and more or less globular or evidently multilocular, a cystic hydrocele may probably be diagnosed. The tapping of the tumor will, however, settle the diagnosis; for in vaginal hydrocele the fluid will be more or less straw-colored and albuminous, while in the encysted it will be watery, non-albuminous, and occasionally, but not always, opalescent, and when opalescent containing, on microscopical examination, granules and spermatozoa.

In examples of old hydrocele, however, the tumor may be opaque, and under such circumstances difficulties may be experienced, yet the history of these cases will tend to throw much light upon the point, for to a certainty it will reveal a disease of very long standing; the tumor will be probably painless and fluctuating and the testis made out to be in its usual position, at the posterior part of the sac. When a doubt exists, a puncture with an exploring trocar and canula will decide the question, as in these cases fluid of a dark color will be drawn off, loaded with cholesterin.

We will now pass on to the consideration of tumors which are not translucent and not hydrocele; and it is here that the surgeon experiences true difficulty in his diagnosis, as almost all the diseases of the testis are insidious in their growth and chiefly painless in their development. The hæmatocele, except in rare examples, usually follows upon some strain or injury, increasing with tolerable rapidity up to a certain point and accompanied by pain, which soon subsides. It then becomes stationary as to size and remains torpid for a variable period, when pain reappears, with other signs of inflammation. The presence of the testis is also to be made out by manipulation toward the posterior part of the organ. The surface of the tumor is always smooth, more or less oval or pyriform, and semi-elastic or fluctuating.

The inflammatory affections of the testis have a peculiar shape, being laterally flattened, and are usually accompanied at some period of their course with tenderness and pain, as well as often associated with fluid in the tunica vaginalis. In the syphilitic inflammation this fluid is often copious. Both organs are also generally involved, either together or at different times. The tumor is usually somewhat tender to the touch, and has a firm fibrous feel unlike the semi-elastic and half-fluctuating sensations afforded by cystic or carcinomatous disease. In very chronic cases the testis may, however, be perfectly painless and allow of any amount of manipulation without distress, the natural testicular sensation, in fact, having disappeared. In syphilitic disease the surface of the tumor will probably be irregular, with firm fibrous outgrowths in different parts and in the tunica albuginea.

In the tubercular affection of the epididymis or testis there should not be any difficulty in the diagnosis, for the tubercular deposit, as a rule, takes place unaccompanied by pain or any symptom beyond that produced by its deposition. When deposited in masses—its usual form—it feels like some foreign body introduced into the substance of the gland or of the epididymis, and is at first quite painless and unproductive of any symptoms; these symptoms only appear when the material begins to soften down and excite some inflammatory action in the parts around. The tubercular material may be deposited in one or more masses, these subsequently, perhaps, coalescing into an irregular induration. When suppuration takes place, the diagnosis is complete.

The cystic or simple tumors of the testis are painless throughout the whole course of their growth and can be recognized by purely negative symptoms. They attract the patient's observation only from their size, can be handled without exciting pain, and do not usually give even the natural sensation of the organ upon pressure. They are slow in their progress, uniform in their outline, and more or less globular, are always confined to one gland, are rarely accompanied with fluid in the tunica vaginalis, and on being punctured emit only a more or less blood-stained glairy mucus.

The cancerous tumors of the organ are more rapid in their development than the cystic, a year's growth, as a rule, giving a large tumor. They are likewise painless, and readily allow of free manipulation. The natural sensation of the organ also soon disappears. They are unaccompanied with a hydrocele, and also involve only one organ. They have a more elastic and fluctuating feel than the cystic or inflammatory enlargements; and when their outline is unequal or bossy, the projection is generally softer than the other portion of the tumor. An exploring needle or trocar and canula rarely, if ever, reveals the mucoid fluid so characteristic of the cystic or simple affections, but usually lets out blood or the thin creamy fluid so characteristic of a cancer. In the preceding table the chief points of difference in the several chronic affections of the testicles are clearly shown. (See Table, pp. 746, 747.)

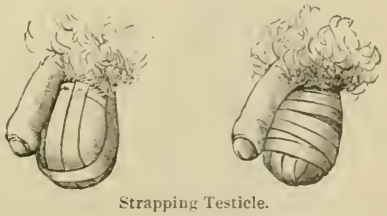
Castration.

The scrotum having been shaven and the skin over the testicle made tense, a free incision is to be made through the scrotum and tunica vaginalis down to the tunica vaginalis testis, and the body of the organ with the cord exposed. When any doubt as to diagnosis exists, an incision should be made into the growth before its removal. A strong double carbolized silk or catgut ligature should then be passed between the structures of the cord and firmly tied in halves; the cord should be divided below the ligatures and the tumor turned out of its scrotal covering. There is no necessity to take away any of the scrotum, however stretched, unless diseased, since it is sure to contract. All vessels should be twisted, the wound washed out with some hot iodine water and dried, and a few sutures put in at the upper part of the wound; a drainage tube should be introduced at the lower part of the wound and the patient put to bed with the purse raised by a small pillow. No pain is caused when the ligature of the cord has been tightly tied. Recovery is, as a rule, rapid after this operation.

To take the vessels of the cord up singly is a troublesome operation and has no advantages. No assistant can hold the cord with his fingers after its division, as it is sure to slip from his grasp.

To strap a testicle requires some skill. The patient should be made to stand against the edge of a table and separate his legs. The surgeon should then with his left hand grasp the organ from behind and press it down to the bottom of the scrotal sac, making the scrotum tense over its surface, the thumb and index finger of his left hand holding its neck. A piece of strapping spread on leather half an inch or more wide is next to be wound round the neck of the tumor once, twice, or even thrice, to hold it in position; for if this point be not attended to, all the subsequent steps will be useless (Fig. 426). Having done this, pieces of strapping three-quarters of an inch long are to be applied vertically from one side of the circular strip to the other, sufficient force being employed to compress the organ. When the testis is completely covered in and compressed, another circular piece or so should be applied, to keep the whole in position and to bind down the ends of the vertical

Fig. 426.



Strapping Testicle.

pieces. The strapping will probably require reapplication every second day, as the parts soon yield and the strapping then forms a loose bag. The student must remember that the object of the strapping is to compress the organ, and not to cover it.

For the purpose of compression a narrow rubber bandage may be employed with advantage.

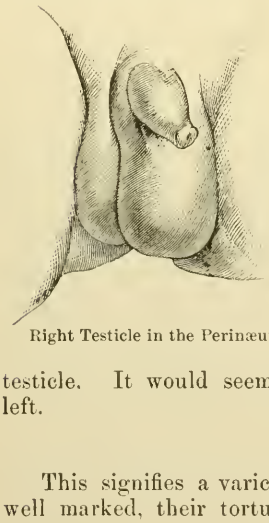
Imperfect transition and malposition of the testicle are occasionally met with, the organ being either arrested in some part of its course into its scrotal pouch or misplaced. At times one testicle is found in the canal or it has failed to put in an appearance, at all, while at others both are found to be out of place. Not uncommonly this arrested descent of the testicle is complicated with a congenital hernia, the vaginal process of peritoneum being still open, and in all cases of scrotal swelling in infants the surgeon should examine the parts with care to discover whether the testicle is or is not involved in the tumor. When the testes are thus placed, they are very commonly ill developed. At times during their descent through the rings they are nipped by the muscular structures and become inflamed. I have recorded such instances in a former page.

Treatment.—Nothing can be done by way of treatment to expedite the descent of the organ. When within the internal ring and complicated with hernia, it is well to recommend a truss; but when the testis is in the canal, such an instrument cannot be worn, an extra element of danger, under these circumstances, being added to the case.

Testes so situated seem to be very prone to become the seat of cancerous disease. Many such cases have been recorded.

In a case under my care, of a gentleman over fifty, an encysted hydrocele was found with a small testicle situated in the centre of a congenital hernia, the cyst on the reduction of the hernia appearing as a tumor the size of a small orange, below the external ring and behind the hernia. I tapped it from behind and drew off about two ounces of a milky fluid containing many spermatoza, and injected it with iodine. A good result followed. This gentleman was married and had a family.

Fig. 427.



Right Testicle in the Perinæum.

Malplaced testicles are less common than those just described. I have, however, seen at least ten cases; in five, one of which I have reported (*Guy's Hosp. Reports*, 1867), the right testicle was placed in the perinæum in its own separate scrotal pouch (Fig. 427), whilst in the other five the right testicle was in the perinæum, but outside the scrotal sac, which was otherwise natural. There was in one a hernia associated with the malplaced testicle, the bowel clearly descending into the tunica vaginalis down to the testicle. It would seem that the right testis is more prone to malposition than the left.

Varicocele.

This signifies a varicose condition of the spermatic veins; and when the disease is well marked, their tortuosity and dilatations present the appearance (Fig. 428) and impart the feeling of a "bag of worms" within the scrotum. It is more common on the left than on the right side, the assigned causes of this preponderance being the more dependent position of the left organ and the liability of the vein to be pressed upon by a loaded sigmoid flexure of the colon. It is a disease of young adult life, and is the cause of the rejection in the British army of about fifteen recruits in the thousand. It is doubtless often, although not always, the product of masturbation or excess of venery; but anything that retards the return of the venous blood from the organ aggravates, if it does not really cause it.

Fig. 428.

Varicocele. (Taken from case of Mr. Jacobson.)

Symptoms.—The affection is generally accompanied by a dull aching pain in the part, as well as a sensation of weight or fulness, but these symptoms are rarely complained of at an early period of the affection. The pain often passes up the groin, even to the loins, and is relieved if the patient assume the recumbent position, or even by elevating the scrotum.

Treatment.—If constipation exists, the bowels must be regulated. If the scrotum be pendulous, cold bathing ought to be recommended and the organ supported by some suspensory bandage. Tonics are often of use. When this palliative treatment gives relief and retards the progress of the disease, nothing more is needed; but when the disease is severe and these means are ineffectual, a more radical treatment is called for, which consists in the excision, destruction, or division of the veins.

Excision is a practice which has been reintroduced since antiseptic surgery has become a fashion, and consists of the removal of about an inch of the diseased vein below the external inguinal ring after the application of a ligature of carbolized catgut above and below the part to be removed. Good results, as a rule, follow this practice, but I have known of bad, and regard the operation as more dangerous than that now to be described.

Operation of Ligature.—This is a subcutaneous operation, and is most successful. Some surgeons employ metallic wire for the purpose, others carbolized silk, catgut, or kangaroo-tendon ligatures. Mr. Lee uses two pins to arrest the flow of blood through the veins and performs subcutaneous division of the vessels between them; I prefer, however, the ligature. Sir B. Brodie used to divide the veins subcutaneously and apply pressure. Mr. J. Wood of King's subcutaneously surrounds the veins with a double wire noose and keeps up pressure upon the wire by means of a metallic spring till the division of the veins occurs. The operation I prefer is performed as follows: Under an anæsthetic or not, the scrotum on the side of the varicocele is to be taken between the fingers and thumb and the vas deferens (which may always be known by its cordy hardness) allowed to escape; so soon as this is done a needle armed with the ligature should be passed through the scrotum *beneath* the bundle of spermatic veins and drawn through. A Liston's needle on a handle should then be introduced through the same skin-opening as was made by the first needle and, passed in *front* of the veins, and its point brought out at the point of exit of the first needle. The ligature first passed is then to be threaded through the eye of the needle, which should be drawn back. When this step has been taken, the bundle of veins have been surrounded and may be occluded by firmly tying the ends of the ligature. It is a good plan, before tying the ligature, to divide the skin at its point of exit and entrance with a tenotomy knife, the loop of the ligature by this step being lost in the tissues and made subcutaneous. A second ligature is to be applied in like manner, half an inch or more lower down or higher up, as the case may be: and after this the veins may or may not be divided subcutaneously between the two needles by a tenotomy knife. Of late years I have left out this part of the operation with no detriment. As a general rule, this operation is most successful, and not dangerous. It is only to be done, however, when palliative treatment fails.

Mr. Morgan of Dublin has recently suggested an admirable suspender for varicocele and other affections of the testis, which is illustrated in Fig. 429. It consists of a piece of webbing four and a half inches long, three and a half inches wide at one end, four inches at the other, and gradually tapering to the narrower end. A piece of thick lead wire is stitched in the rim of the smaller end, two tapes sewn along the entire length of the webbing, and the sides furnished with neat hooks, a lace, and a good tongue of chamois leather. When the suspender has been applied to the testicle, the tapes are to be attached to an abdominal belt. The size may vary more or less. The lead wire encircling the lower end gives a foundation to the general means of support and keeps the testis within the bag; the patient can mould it more or less to his convenience, and it need not be worn at night.

Fig. 429.

Morgan's Suspender.

Fatty tumors are occasionally met with in the cord—I have removed one the size of a walnut—and fibrous or sarcomatous tumors have been met with on the testicle. I have seen one of the latter, the size of an orange, excised by Mr. Hilton from the testicle with success.

Affections of the Scrotum.

The scrotal pouch is very frequently the seat of injury, while the testicle, from its mobility, escapes. When the parts are bruised, the effusion of blood is at times very great, the blood forming a large diffused scrotal hæmatocele, while at others it forms a

distinct tumor. On January 29, 1871, I was consulted by T. B——, æt. 40, who sat down on the broken arm of a chair, the stump of the arm bruising the perineal border of the scrotum. A swelling at once appeared; and when I saw him, twenty-six hours after the accident, a well-defined blood tumor the size of a cocoanut existed in the median line of the scrotum, the two testicles maintaining their position on either side. By rest, cold lotion, and tonics the blood was absorbed in three months.

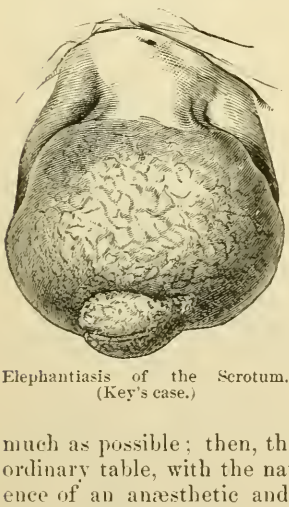
Lacerated wounds of the scrotum are also attended with blood extravasation, but they usually heal readily, on account of the vascularity of the parts.

Œdema of the scrotum takes place when inflammation attacks neighboring structures. It is seen in the inflammation of the epididymis associated with gonorrhœa and in acute orchitis; in extravasation of urine and urinary perineal abscess; in the retention of urine in childhood due to the obstruction of a calculus; in phimosis or paraphimosis; in erysipelas. In all these cases it is present with more or less redness and external signs of inflammation.

Simple œdema is one of the first indications of renal or cardiac dropsy.

Elephantiasis of Scrotum.—Not rarely the scrotum is the seat of *elephantiasis arabum*—solid œdema of the scrotum—and the disease generally attacks the penis as well. In tropical countries, where this affection is common, the tumors attain an enormous size. It is the same disease which attacks the female genitals and other parts of the body and extremities, and in the West Indies is known as the "Barbadoes leg." By Mr. Dalton of Guiana and other observers it is regarded as a constitutional disease. For its true pathology refer to p. 178. It is occasionally associated with ichthyosis of the tongue and is often attended with fever and local erythema with œdema, which never subsides. When attacking the scrotum, nothing but its excision is of any use. The historical case in which Mr. Key removed from a Chinaman æt. 32 a tumor weighing fifty-six pounds (Prep. 1620^{69}, Guy's Museum), of ten years' growth (Fig. 430), is a good case in point; but the growths attain a larger size than this. Mr. Wiblin in 1862 excised a growth equally large, and in the *Med.-Chir. Trans.* for 1863 the report of his case will be found, with a reference to others. Such growths are made up of the elements of ordinary connective tissue.

FIG. 430.



Elephantiasis of the Scrotum. (Key's case.)

Sir. J. Fayrer, who has operated on many cases, writes:

"The operation for removal of a scrotal tumor is simple enough, but it requires determination and expedition. It also needs the aid of intelligent assistants. Before commencing it is well to have the tumor raised and supported in a vertical position for half an hour, to drain it of blood as much as possible; then, the patient having been placed in a recumbent position on an ordinary table, with the nates brought near the end of it, he is to be put under the influence of an anæsthetic and the incisions are to be commenced. Several assistants are required, to hold back the legs, raise the penis and testes, support the tumor, and rapidly secure the bleeding points. These being provided, the operation may be begun. The director is to be introduced into the passage at the bottom of which lies the glans penis, and that organ exposed by laying open, with either the long catlin or the sharp-pointed bistoury, the dense tissue covering it. If the prepuce is healthy, it is well to reflect a portion of it as a future covering to the penis. If the prepuce is involved, or even suspected of being involved, it should be carefully dissected away, like the rest of the thickened tissue. Having exposed the penis, it is to be raised and carefully dissected out, with or without the prepuce, as the case may be. This is to be raised and held aside by an assistant, care being taken in clearing it out of the morbid tissue not to divide the suspensory ligament.

"The next step is to make a deep and bold incision down to the tunica vaginalis on one side. In a large tumor several incisions will be needed before the tunica vaginalis is exposed, which probably will be found much thickened and distended with fluid, forming large hydroceles. These should be laid open, and if the tunica vaginalis be much thickened it should be removed; if not so affected and the testicle not enlarged, it need not be interfered with. The testicle is then to be dissected out, reflected, and held upward with the penis. A similar proceeding is to be carried out on the opposite side. The tumor is then to be removed by connecting transversely the three vertical incisions already made, and

then, with either the scalpel or the amputating knife, the remaining portion of the neck of the tumor is to be cut through. It is well before separating it to mark out on the perineal aspect by an incision the line at which the removal is to be completed. During the operation vessels are to be commanded by the fingers of assistants and large veins controlled by forceps. It is well that even the most minute bleeding point should be ligatured (or twisted); otherwise, when reaction occurs, there may be hemorrhage. The bleeding having been controlled, the testes with their elongated cords are to be applied to the surface of the wound; the penis is to be enveloped in a fold of oiled lint and thus kept apart from the testes, which are also covered and supported in position by oiled cloths."

The largest tumor of this kind on record weighed two hundred pounds.

Dr. Turner of Samoa (*Glasgow Med. Journ.*, January, 1883) uses a clamp with a notch in its centre for the urethra, to compress the base of the scrotum after it has been drained of its blood by elevation. He likewise lays great stress upon the propriety of dissecting out the penis and the testicles before any attempt is made to remove the tumor. Other surgeons have used a rubber tube to compress the base of the tumor.

Cancer of the Scrotum.

This is a rare affection compared with what it was some years ago when sweeps ascended flues. It is still, however, met with in this country as a *chimney-sweep's cancer*. On the Continent it is well known in the tar and paraffine manufactories, the products of distillation of coal, according to Volkmann, being more irritating to the human skin than soot. The disease is in reality an epithelial cancer similar to that found in other parts of the body; at times it is very extensive and involves the whole scrotum.

Treatment.—Nothing but its removal can be recommended. Small tumors may be cauterized down or destroyed by caustics, but the larger should be excised. When the growth can be isolated by pins passed through its base, the platinum wire écraseur heated by the galvanic battery is probably the best instrument to use; otherwise, the knife is to be employed. When the whole scrotum is removed and the testes are left exposed, hanging from their external rings, the surgeon need be under no alarm, for the parts will granulate up in the course of time, and, what is more, the testicles may become movable. I have seen this take place more than once. The earlier the disease is removed, the better; for by delay the glands of the groin may become involved.

Other Diseases of Scrotum.

The scrotum is occasionally, though rarely, the seat of tumors, sebaceous, fatty, fibrous, or sarcomatous. It is likewise the seat of varicose veins, the small venous radicles appearing as beaded dilatations of a peculiar aspect; the disease is, however, of little importance.

Tumors or swellings that encroach upon the scrotum from the perinæum are probably inflammatory, and are most frequently urinary abscesses associated with and dependent upon some stricture; but occasionally an anal abscess may press forward, and I have seen one occupying the whole perinæum up to the scrotum. These are to be treated by free incisions.

STERILITY.—MALE IMPOTENCE AND SPERMATORRHŒA.

The influence of the sexual functions is so great in the economy of human life that any impairment of the organs concerned is a matter of importance, not only in its effects on the bodily health, but even more on the mental state of the person affected.

The sexual act is a compound one, physical and mental. The physical organs may be perfect and capable in their way; but if the mental are deficient in energy or weakened by doubt of competency, or under the influence of some emotion such as shame or fear, the sexual act will be spoilt, and failure to complete it must ensue.

It is, therefore, clear that impotence, real or imaginary, may be due to either physical or mental causes.

Taylor defines *impotency* to be "an incapacity for sexual intercourse." This incapacity may ensue from physical causes, remediable or irremediable. The latter includes loss of penis and testicles, deformity of penis, including excess of and arrest of development, maldevelopment in such cases as ectopia vesicæ, etc. The remediable causes may be some local affection of the penis or testes.

Any condition that prevents the introduction of the organ into the female passage is enough to cause impotence, whether such condition be connected with the penis or with the testes. The same effect is produced by any disease or congenital malposition or development of the testes attended with loss of sexual desire, as by old age. A man may, therefore, be impotent and virile or impotent and sterile.

A man may be capable of sexual intercourse and yet be sterile, sterility in the male depending much upon the secretion of the testes, as well as upon the formation of the penis; for semen without spermatozoa is destitute of procreative power. A man may have a penis the subject of epispadias or hypospadias; he may have sexual desire, and even power, but if the urethral orifice be so low down as to prevent the semen from being conveyed into the vagina he will be sterile, though all patients with hypospadias are not so. I have known two men who had hypospadias—the orifice of the urethra in each opening one inch behind the normal urethral opening—to be the fathers of three and four children respectively, and a third, in whom the urethral orifice was one inch behind the glans, whose wife died in childbirth.

When the urethral orifice is at the base of the penis, sterility must, however, exist. When partial epispadias exists, there is no reason to believe that a man must be sterile.

When both testes are misplaced—that is, when they have not descended into the scrotum—there is a strong probability that the organs are badly developed, that they do not secrete healthy spermatic fluid, and that sterility is the result. Curling asserts this very positively to be the fact, but he at the same time brings forward evidence from Messrs. Cock's and Poland's practice that such is not always the case. In a general way Mr. Curling may be right, but there are many exceptions to such a rule. When one testis is in the scrotum and healthy, there is no reason to suspect sterility.

Sterility sometimes follows disease of the testes, inflammatory or otherwise; for epididymitis or inflammation of the duct of the testicle, as well as testitis or inflammation of the gland, may be followed by atrophy of the organ. Gosselin, Godart, and Liegeois have laid great stress upon this, and Curling ascribes these as common causes of sterility. Sterility may also be produced by involuntary seminal emissions the result of excess of venery or masturbation by producing either loss of sexual power or deterioration of semen. Stricture or any impediment to the seminal discharge is also another cause. The student must remember, too, that a man may be capable of sexual intercourse and be sterile from other causes. He may even have emissions in connection without seminal secretion, for the emissions may consist only of secretion from the seminal vesicles. I have known this fact illustrated in a man who had lost both his testicles from a surgical operation and yet had sexual power as strong as ever, attended with emission. The removal of one testicle seems to interfere but little, if at all, with sexual power. Some years ago I removed a testicle for cystic disease from a gentleman who had been married many years and had no child. After the operation his wife soon conceived and gave birth to a boy.

In the *female* subject impotency may be said to exist when the vagina is absent or obliterated. It is for a time present when the orifice is occluded by some dense membrane, or when the introduction of the male organ is prevented on account of the smallness of the orifice, by vaginismus, or from the presence of a bifid vagina.

Sterility is due to many causes, the occlusion of the os uteri being one, but morbid conditions of the uterus and ovaries are probably the more frequent.

The student should remember that "the functions of the testicle, like those of the mammary gland and uterus, may be suspended for a long period—possibly for life—and yet its structure may be sound and capable of being roused into activity" on any healthy stimulus. Unlike other glands, it does not waste or atrophy for want of use, the physical parts of man's nature being accurately adapted to the necessities of his position and to his moral being.

Spermatorrhœa.

This doubtless exists as a disease, although rare. It consists in the discharge of spermatic fluid containing spermatozoa with the urine, without sexual desire or sexual excitement. It is commonly associated with some derangement of the digestive organs, constipation, and rectal irritation, spasmodic action of the levator ani acting on the vesiculæ seminales and prostate gland. In its most complete form it is associated with an absolute loss of sensation about the veru montanum on the passage of a sound, a patient thus affected allowing the introduction of an instrument without flinching, whilst the worst cases are associated with wasting of the testicles and varicocele. It is at times, without

doubt, due to excess of venery, but more commonly to masturbation. It commences almost always with nocturnal emissions, which gradually become more frequent. These are at first attended with erotic sensation, although not so subsequently, and at last occur without erection. If copulation be attempted, the ejaculation takes place at once, often before the introduction of the organ. It ends in the total loss of sexual inclination and power. Lallemand says that "seminal emissions supervening during micturition are the most serious."

He holds that "spermatorrhœa is nearly always dependent upon irritation of the prostate gland and its ejaculatory ducts," and believes that "in most cases this irritation, which also exists in the neck of the bladder, is the result of chronic inflammation of the urethra in the prostatic portion of the veru montanum. An old attack of urethritis is the most frequent cause of the seminal emissions, and these emissions are often related to stricture of the urethra."

Trousseau, however, while admitting the force of these observations, believes that spermatorrhœa or incontinence of semen is due to some imperfection in the nervous system of organic life, since it is so commonly found in men who have had incontinence of urine in childhood. He looks upon the masturbation as an indirect proof that there is a bad state of the nervous system, and the subsequent impotence, insanity, or paralysis as an aggravation of a nervous condition of which masturbation was only the first morbid manifestation (Trousseau, *Clin. Med.*, vol. iii.). This latter view is supported by the fact that in some cases of injury to or disease of the spinal column spermatorrhœa is a common associate.

False spermatorrhœa is, however, a more common complaint. It is supposed to be present when nocturnal emissions are frequent, when diurnal emissions take place on any sexual thought and urethral discharge of a glairy fluid attends defecation, when erections with discharge follow the slightest irritation, such as that produced by riding or walking, from the friction of trousers, etc. Such cases are far from rare and are commonly due to masturbation, but are not cases of true spermatorrhœa, although they often precede it. Nocturnal emissions may be too frequent; but if associated with sexual feeling, they are natural. They should, however, be checked, as they lead on to the true disease. The glairy fluid pressed out in defecation is rarely seminal, but is prostatic, of a transparent, tenacious character, and not milky. The whole genital tract in this affection is in a state of morbid sensibility, of hyperæsthesia, and requires treatment, since the false spermatorrhœa is often only the prelude to the true.

Treatment.—Trousseau, regarding masturbation as a manifestation of some disease of the nervous centres, speaks strongly in favor of belladonna, and, so far as my experience has gone, I am disposed to think it a valuable drug given in half-grain doses of the extract twice a day, with some tonic such as iron, zinc, strychnine, or quinine. It seems to act most beneficially, and in a marked manner to check the disposition to masturbate. Of course this good can be met with only when there is in the patient's mind a strong wish to overcome a repugnant habit. To aid this the application of a ring of blistering fluid around the penis or painting the prepuce with iodine is a valuable adjunct. The bowels, more particularly the rectum, under all circumstance, should be kept empty, and the nightly injection of cold water into the bowel is a useful custom. The patient should sleep upon a hard bed and be lightly covered. He should not rest on his back, and a solid substance fastened in a handkerchief over the sacrum is a good mode of securing this end.

When evidence exists that the mucous membrane of the prostatic urethra is affected near the orifices of the spermatic ducts, Lallemand's advice of applying a solution of nitrate of silver (gr. v to gr. x to the ounce) every other day should be followed. Some surgeons use a stronger solution; and when an absolute loss of sensibility of these parts is present, galvanism has been highly spoken of. For the application of the solution Erichsen's syringe catheter is the best. Every means should be employed to divert the patient's mind from the seat of his affection by encouraging mental as well as physical labor. Simple nutritious food should be allowed and cold bathing adopted.

In the cases of imaginary impotence of young married men all that the surgeon has to do is to give confidence, for the failure is probably in the mind rather than in the body of his patient. The best advice is to recommend abstention from coitus, when Nature in her own time will have her way and assert her power.

CHAPTER XXV.

SURGICAL AFFECTONS OF FEMALE GENITALS.

Wounds.

Wounds of the external genitals are met with in practice as the result of violence intentionally committed or happening accidentally from falling or sitting on pointed or cutting bodies. They are always serious, on account of the bleeding that attends them, and wounds of the vagina are particularly so. However severe they are, they should be carefully cleansed, adjusted, and stitched together; for these tissues are very vascular and heal well.

Severe lacerations at times takes place in the attempt at coitus. Some years ago I was called to a young married woman for severe hemorrhage from these parts following marital intercourse the night after marriage, and found two severe lacerations of the orifice of the vagina and the hymen unruptured; the membrane had been practically driven in. Pressure arrested the bleeding.

Wounds of the vagina are apt to be followed by inconvenient cicatrices.

Foreign bodies are also at times introduced into the vagina for criminal or erotic purposes. Mr. Hilton removed at Guy's a flat bone-netting mesh ten inches long which had passed through the vaginal walls into the pelvis. Bottles and other foreign matters have also been introduced. Sponges are not uncommonly found in the passage, and in a case I knew of such a foreign body gave rise to the suspicions of cancerous disease.

Adherent Labia.

The labia during childhood are apt to adhere together from some local inflammatory action, and so to close the labial orifice as to interfere with the act of micturition. The urine in children thus affected often squirts in a backward or forward direction, and for this surgical attention is sought. In these cases the true condition of affairs will at once be recognized on separating the genitals, for the labia will be found connected together by a membranous adhesion which passes forward in some cases to the urethral orifice, thereby affecting the urinary stream. This membrane is readily broken down by separating the labia with the fingers or thumbs, or by means of a probe introduced behind it from above. The application of a little cold cream will complete the cure if care be taken to keep the parts clean.

Vulvitis.

This is a common complaint in children, and is almost always due to some rectal irritation such as that caused by worms, scybala, etc., in the feeble and badly fed. It is rarely the result of a gonorrhœal affection, as is too often suspected; and it is well to be aware of this fact, as it is not uncommon for a surgeon to be consulted about a child with vulvitis under the suspicion that the affection is the result of an impure criminal contact, when it is due to some simple non-venereal cause.

Treatment.—It should be treated by local cleanliness and mild astringent lotions such as lead, alum, etc.; when worms are suspected, by the administration of a good mercurial or jalap purge and attention to the digestive organs and general health; a mixture of rhubarb and soda for a few days, and subsequently a tonic, generally effect a cure.

Noma, or phagedænic ulceration of the labia similar to the cancrum oris after the exanthemata, is met with in cachectic children and is a disease of debility. It commences as an inflammatory swelling of the parts similar to erysipelas, passing on to gangrene and ulceration, and is always attended with great prostration.

Treatment.—For its treatment such tonics as can be borne should be given, and particularly iron, quinine, or bark. Wine and abundance of good liquid nourishment should be given by the mouth, or by the rectum when the stomach rejects it, and milk with chlorate of potash is a good drink. Locally, opium lotion with carbolic acid, nitric acid, or nitrate of silver should be used; and when the ulceration spreads nitric acid in its concentrated form may be applied, or the actual or galvanic cautery.

Nævi, when found involving these parts, are to be treated like others.

Hernia.—In women the labium may be the seat of an inguinal *hernia* or of a *varicocele*. The former is known by its own symptoms, the latter by its wormy feel. It may also become the seat of **thrombus,** or blood tumor on the receipt of an injury, which is to be made out by the history of the case, the sudden appearance of the swelling after an injury, its external aspect and fluctuating feel. Such blood swellings are to be treated at first by the local application of cold, to arrest the flow of blood, and subsequently by lead lotions. If they tend to break up and form an abscess, a free incision into the swelling is the right treatment to adopt.

Labial abscesses form at times as a result of a softened thrombus, but more frequently from follicular inflammation. They are very painful and ought to be opened early. Occasionally they are the consequence of an inflamed cyst.

Labial cysts are very common, and are usually met with on the inner side of the labia. They are similar in their nature to the mucous cysts found in the mouth or about the tongue and are formed in the same way, by the obstruction of the ducts of the mucous glands of the parts. They appear as chronic painless swellings, producing only mechanical inconvenience; but if neglected, they may inflame and suppurate. On manipulation they feel tense, globular, and semifluctuating, and contain a glairy brown or blood-stained fluid, at times with cholesterin.

TREATMENT.—They are to be treated by excision or the removal of the presenting surface of the cyst by a pair of forceps and scissors, the removal of one wall exposing the other, which contracts. Excision, however, is the safest practice. When an opening into the cyst is made, the cavity should be plugged with lint or with lint soaked in tincture of iodine, this fluid exciting adhesive action or suppuration in the cyst wall. When the cyst suppurates, it is to be laid freely open and dealt with as an abscess.

Mucous cysts like these are also found in the vagina.

Sebaceous Tumors.—The internal labia may also be the seat of sebaceous tumors and of a solid œdema or hypertrophy similar to that seen in the male scrotum, not unlike *elephantiasis*, and grow to a large size. Nothing but their removal can be entertained. Some time since I removed with the galvanic écraseur from a middle-aged woman both labia, which had attained the size of a cocoanut, without the loss of a drop of blood, after having isolated the growths by long pins inserted through their bases and passed the wire round the pins. When this instrument cannot be obtained, the knife must be employed. Such tumors are highly vascular, and the surgeon requires good assistants in their removal.

Cancerous tumors, both epithelial and otherwise, of these parts are also met with, and are known by their ordinary features; they should be treated by removal. It seems that cancer is prone to appear in these regions at an earlier period of life than in others. In 1869 I removed a well-marked cancerous tumor from the labium of a woman only thirty-two years of age.

Epithelial disease of the clitoris occurs at times, and I have seen several well-marked cases; but more commonly it attacks the inner labia and orifice of the vagina. In such cases the benefit of the galvanic cautery is well illustrated, for the removal of these growths by excision is very difficult and always attended with copious bleeding. When the whole growth cannot be isolated, as much as possible should be excised or scraped off and the cautery freely applied to the surface and base of what remains. Where the growth can be isolated by the introduction of long pins beneath its base and a wire adjusted beneath the pins, the galvanic écraseur, not made too hot and slowly worked, is an admirable instrument to employ. By its means I have on several occasions successfully removed, without the loss of a drop of blood, an epithelial cancer occupying the fourchette of the vagina, encroaching on the passage and the perinæum. The patients were under chloroform during the operation and felt no pain, the after-pain in these cases being always slight, the cautery entirely destroying the sensibility of the divided parts. Wounds so made heal kindly.

Lupus also attacks these parts like others, while *warty growths* are common.

Syphilis has received attention in another page.

Imperforate hymen is a condition to be recognized and not confused with the adherent labia, already referred to. The hymen is more deeply placed, nearer the orifice of the vagina. When imperforate, it causes retention of the menses, the accumulation of the secretions, and a pelvic tumor usually accompanied by periodic pain and constitutional disturbance.

TREATMENT.—The proper treatment of these cases is the division of the imperforate membrane or its complete excision, the object being to allow of the free escape of the

retained secretion, which is usually black and treacle-like. Success usually attends this practice, though a fatal peritonitis at times ensues.

A rigid hymen is occasionally an impediment to coitus in women who marry late in life, and I have known one in which for two years after marriage the husband had never had perfect connection on this account; indeed, it was not till after his wife had become pregnant and the vaginal membrane had been ruptured during the birth of the child that a satisfactory coitus was effected.

I have also been called upon on one occasion to divide the hymen of a lady about thirty who had been married for some months and had never had complete connection, the husband's penis having been very large.

There are cases on record showing that when a vagina is occluded and the patient has been married, the urethra has been so enlarged as to admit the finger, and in all probability the male organ.

A double vagina is another cause of difficult coitus. I was consulted in such a case by a patient who had been married for several years and never had connection. The woman came to me, as a divorce was under consideration. She complained of extreme pain whenever an attempt at coitus was made, and the husband of inability to penetrate. On making a careful examination a double vagina and uterus were discovered. I advised the division of the septum with the galvanic wire by perforating the septum near the uterus and gradually dividing it by means of steady traction upon the wire; but whilst the question was under the consideration of both parties the suspicion of pregnancy occurred, and time proved its truth. A child was born prematurely after a tedious labor, and I heard no more of the difficulties of the case. She became pregnant a second time.

Besides these deformities, others may occur, such as occlusion of the vagina or absence of the uterus, or the opening of the rectum into the vagina, etc.

Enlarged Clitoris.—The clitoris is occasionally enlarged at birth, appearing as a small penis. I have seen an example of this, and at the end of the clitoris a depression existed corresponding to the male urethra. The child in other respects was natural. This organ, however, may in after-life become the subject of hypertrophy—indeed, of a kind of elephas, as of the male penis—and require removal.

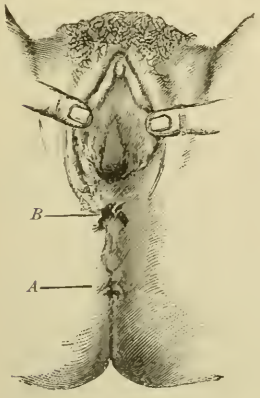
Clitoridectomy for epithelial cancer has already been alluded to. This operation has been practised for epilepsy and supposed erotic complaints, but evidence is wanting to justify this step. The operation for such purposes appears at present to be unjustifiable.

Vaginal tumors, besides the cystic and epithelial, are occasionally met with, and vaginal polypi are found. I removed one the size of a nut from a child three years old, and similar cases are on record. They should always be ligatured and excised.

Rupture of the Perinæum.

This accident is not rare as a result of a rapid delivery, and to a small extent it is somewhat common in first labors. When limited, it is not of much importance; but when extensive the pelvic organs lose their natural support and are liable to fall, giving rise to *rectocele*, or prolapse of the posterior wall of the vagina, or *cystocele*, or prolapse of the anterior wall of the vagina.

Fig. 431.



Central Rupture of the Perinæum, through which Child was born.

When the sphincter ani or the rectum is implicated, the accident becomes of grave importance.

At times the rupture is central, and in the case from which Fig. 431 was taken the child was born through the rupture B. The incident took place in the practice of a medical friend, who sent the case to me. Dr. Wilson witnessed a like process in a similar case (*Edin. Med. Journ.*, April, 1875).

There is no reason to believe that rupture of the perinæum is in all cases the fault of the accoucheur, although, doubtless, it is so in some; yet with a large child and rapid labor it is often difficult to prevent. I have known it occur in the practice of very good men.

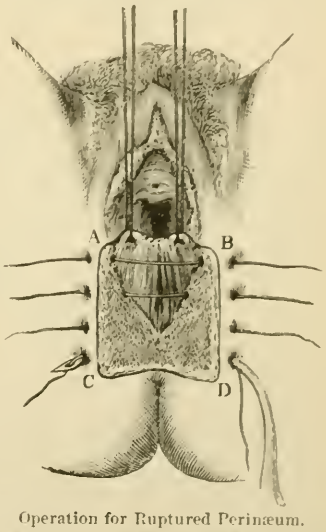
Treatment.—Slight ruptures of the perinæum need not be regarded, but when a rupture into the body of the perinæum takes place during labor and the accident is recognized, the best practice is to put in one or more sutures at once. This practice is so sound that it cannot be too confidently recommended.

When the operation is not performed at once, but postponed to the future, it must be left till the period of suckling has passed and the general health of the patient been restored; the operation, being a plastic one, requires good power on the part of the patient, and immediate union of the wound is wanted for success. It is very successful when properly performed; indeed, it rarely fails.

Operation.—The bowels should be well cleared out by an aperient given two days before and an enema on the day of operation. An anæsthetic should be given, the patient placed in the position for lithotomy, with the buttocks brought to the edge of the table, and Clover's crutch applied, to keep the knees apart. The vagina should be well washed out with a carbolic acid or iodine lotion. An assistant should then well separate the labia, while the surgeon with his scalpel maps out the portion of the integument that he proposes to raise (A, C, D, B, Fig. 432), remembering that it is necessary to have a broad surface to bring together as well as a cleanly cut one, since a thin membranous union is useless and a jagged surface will not unite.

At least an inch of raw surface should be provided on either side of the perinæum for union, the width of the bared surface diminishing slightly toward the anterior portion of the labia and widening toward the anal end. *No tissue is to be sacrificed.*

Fig. 432.



Operation for Ruptured Perinæum.

A, C, B, D, represents the surface from which the flap is raised, with the sutures introduced prior to the approximation of the two sides.

The incisions should be carried along the outer border of the cicatricial tissue, and extend from A to C and from B to D, with a transverse cut from C to D, and this broad flap is to be raised toward the vagina and held up by an assistant, two sutures inserted into the angles of the flap helping this act (Fig. 432).

If bleeding follows, the larger arteries may be twisted, while a little pressure soon controls the smaller.

The *second* step of the operation, or the introduction of the sutures, remains to be performed; and it is of no less importance than the first. Four or five sutures are required, and they should be of silkworm gut; they should be introduced from a quarter to half an inch from the margin of the wound, the one nearest the rectum being first inserted. The introduction of the first suture is of primary importance. It should be passed deeply through the left side of the wound, rather behind the level of the recto-vaginal septum, through the tissues and the septum, and out at a corresponding point on the right side; it should be completely buried in its whole course, with the object of drawing the recto-vaginal septum well forward (*Vide* Fig. 432). A second, third, and fourth may then be introduced, as indicated in the drawing.

A needle such as that seen in Fig. 432 is the one I employ. It is curved on the flat, so as not to cut the recto-vaginal septum in its passage, and has an eye in its point to admit the suture. The parts should be brought together carefully and pressed together firmly after their apposition; several superficial sutures of fine carbolized gut may be introduced should they be required. If there be much spasm of the sphincter, the muscle may be well stretched.

After-Treatment.—After the operation is completed the surgeon should satisfy himself that the parts are in apposition, and the vagina should be well syringed. Some iodoform gauze should be applied to the wound with some iodoform powder, and a morphia suppository placed in the rectum to relieve pain and spasm.

The patient ought then to be removed to bed and her legs tied together and flexed upon the abdomen. The urine should be drawn off every six hours for the first three or four days and the parts kept clean. Iced milk and beef tea should be given for the first day, but meat and wine subsequently if the appetite allow. The patient may lie on her side should she wish. The sutures need not be removed till the fifth or sixth day, but after the fourth day they should be taken away if suppuration appears in their track.

On withdrawing the sutures great care should be observed not to separate the thighs or parts; indeed, for quite ten days or more after the operation this point should be observed.

After the first week the use of the catheter may be dispensed with, the patient mak-

ing water on her hands and knees, the parts subsequently being carefully sponged. When any offensive vagina discharge appears, the passage may be syringed with an antiseptic lotion. The bowels should be locked up for at least a week by small doses of opium twice a day, and then relieved by a dose of castor oil after some warm oil has been injected into the bowel; but in some cases, where union is thought to be feeble, it is well to keep them from acting for a longer period, care being always observed that no large indurated motion be allowed to pass, warm water and oily enemata being used.

With this attention good success generally follows, and women may have subsequent labors without any giving way of the parts.

Where much prolapse of the posterior wall of the vagina coexists, a strip of mucous membrane running up the vagina from the anal end of the recto-vaginal septum may be cut off and the edges of the wound brought together. I have done this in many cases with an excellent result; indeed, in many cases of prolapse of the uterus following some slight rupture of the perinæum, or even without, this operation is of great value.

In vaginal cystocele a like operation is of benefit, the removal of a piece of vaginal mucous membrane at its labial border being often followed by a good result.

Dr. Kaspozilo in this operation catches the fold of mucous membrane to be removed, when drawn down, between the blades of a pair of long forceps, passes the sutures below the forceps, and finally cuts the mucous membrane away, and then ties the sutures.

Operations for Prolapse of the Uterus

are of great value, and consist, with certain modifications, of the removal of vertical portions of the posterior vaginal wall, though Marion Sims prefers the excision of an oval portion of the anterior.

To do Sims's operation the patient should be placed in the position for lithotomy, and the uterus or anterior vaginal wall near the uterus should be seized with a vulsellum or bullet forceps and drawn well downward. The surface of mucous membrane to be removed should then be marked out with a scalpel, and a piece from the neck of the uterus to the urethra, about three and a half inches long to two and a half wide, removed. All bleeding vessels should be twisted or tied with catgut and the edges of this gaping surface brought together by alternate deep and superficial sutures, these sutures being introduced about a third of an inch apart. The wound should then be well washed with an antiseptic lotion and the parts returned into the pelvis.

The stitches need not be removed for two or three weeks; and when carbolized gut is used, they may be left alone to come away.

When a portion of mucous membrane is removed from the posterior vaginal wall, there is no necessity to draw the uterus or vagina down; but a triangular (Hegar), five-sided (Simon's), perpendicular, or other shaped portion of mucous membrane should be removed and the cut edges brought together, as in Sims's operation, the lower border of the flap under all circumstances corresponding to the junction of the vaginal mucous membrane with the skin.

In all these operations it is of importance that the bared surfaces should be clean and smooth and that there should be no blood beneath the flaps.

Vesico- and Recto-Vaginal Fistulæ.

Abnormal communications between the bladder or rectum and the vagina are usually the result of long and tedious labor from sloughing of the tissues after too much pressure, although at times they may be caused by the rough use of instruments, the retention of a pessary, or the presence of a stone. They are usually discovered a few days after the delivery by urine, wind, or feces passing through the vaginal passage, these symptoms appearing on the separation of the slough.

The surgeon is usually called upon to treat the case when the puerperal month has passed and the patient's powers been restored; till then it would be rash to think of interference.

The operation for the cure of these affections is a very good one and generally successful, failure following only in exceptional instances—that is, when the subjects are feeble, with small reparative power, or when the loss of tissues is too great to be made up.

Recto-vaginal fistulæ are more readily cured than vesico-vaginal, but both operations are alike in principle.

Operation.—Without going into its history, full details of which can be found in the special works on the surgical diseases of women, it may be said that it is by Sims and Bozeman in America, and by Simpson and Brown in this country, that the modern operation has been brought to its present state of perfection, although it is probably to the introduction of anæsthetics that its great success is to be attributed.

Very small fistulæ may probably be cured by the actual or galvanic cautery, but every opening above the size of a crowquill demands some plastic operation.

In the operation the surgeon has three main points to observe: 1st. To bring the fistula well into view and under control; 2d, to pare with nicety and accuracy its whole margin; and 3d, to bring into and maintain in apposition the raw and incised surfaces.

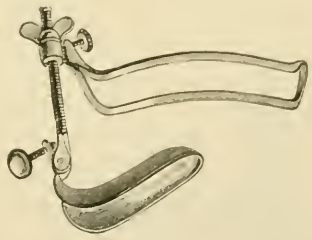
For the first object the duckbill speculum is undoubtedly the best; by some authors it is spoken of as Bozeman's, by others as Sims's. It is both a dilator of the vagina and a retractor. Some surgeons, Jobert being amongst them, talk of exposing the fistula by dragging the uterus externally and thus everting the vagina. I have never had the boldness to use sufficient force to do this, and cannot advise it. Such a measure would, however, greatly facilitate the different steps of the operation.

Weiss has recently so arranged the duckbill speculum as to be self-supporting (Fig. 434). I have used the instrument, and have been much struck with its value.

Fig. 433.

Position of Patient for Vesico-Vaginal Fistula.

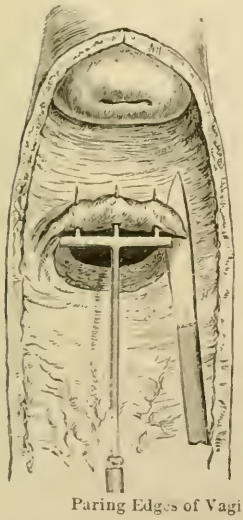
Fig. 434.



Self-Retaining Vaginal Speculum.

For recto-vaginal fistula the patient should be placed on her back, as in lithotomy, and for vesico-vaginal fistula this position is at times the most convenient, though I usually prefer the semi-prone position, the knees and thighs falling over the end of the table, the surgeon looking down upon the fistula (Fig. 433). When the uterus is dragged down sufficiently far to evert the fistula, the lithotomy position is doubtless to be preferred.

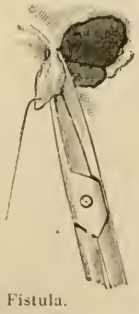
Fig. 435



Paring Edges of Vaginal Fistula.

The fistula having been brought well into view, the next step is to pare its edges; and in doing this the operator must not be too sparing of tissue, his aim being to obtain as broad and as clean a surface as he can. When this can be secured by means of a knife and forceps, no better instruments are required, the best knife being one that can be adjusted to any angle with rapidity and ease. When the fistula is high up in the vagina or large, the pronged guide (a modification of that of Hilliard of Glasgow) made for me many years ago is an excellent instrument (Fig. 435). It is readily applied and ensures a clean-cut surface. Some surgeons prefer the scissors (Fig. 436).

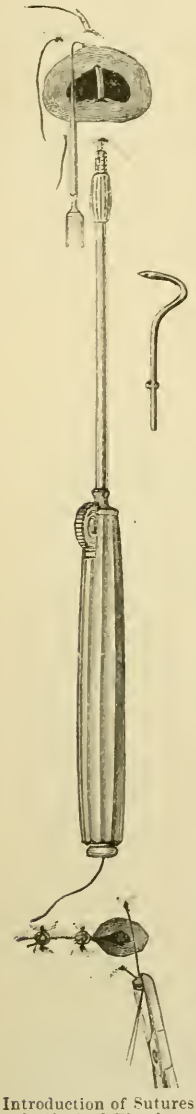
Fig. 436.



When this step of the operation has been completed, the edges of the fistula must be brought together; and for this purpose numerous devices have been employed. Splints of all kinds have been suggested, but with experience they have all been discarded, simple wire, silkworm-gut, or silk sutures, fastened with shot or otherwise, being preferred. I have tried every form of splint, and have at last come to gut sutures with or without shot fastenings, using occasionally a plaited fishing silk.

The sutures should be introduced tolerably close together and at a good distance—say a third of an inch—from the margin of the wound, and should not be drawn too tight. They should be fastened by running a perforated shot down over them, taking the precaution subsequently to tie the gut over the shot to prevent its giving away. In this step the operation is similar to that for fissured palate. In Fig. 437 may be seen the needles employed, with the mode of introducing and securing the sutures.

Fig. 437.



Introduction of Sutures in Vaginal Fistula.

A good strong pair of forceps is required to nip the shot after they have been slipped into position.

When wire or gut is employed, Startin's hollow needles may be used, but the ordinary curved needles with good eyes at their ends are the best for silk. With wire, gut, or silk, the shot fastenings are the best.

After-Treatment.—After the operation the vagina should be well cleansed of blood and the bladder emptied. Ice or iced water will generally arrest any bleeding that may ensue. An opiate suppository should be administered after the operation, to give ease, and the same practice should be followed with respect to the bladder and diet as has been recommended after the operation for ruptured perinæum.

To leave a catheter in the bladder after the operation for vesico-vaginal fistula often adds to the irritation, its careful introduction at stated periods being preferable. When from circumstances this cannot be attended to, the introduction of a short catheter with an open end, to allow of the urine passing as it is secreted, should be employed. Dr. Meadows allows his patients to pass their urine in the natural way after the operation, and I have dispensed with the catheter in some cases without any bad result.

On the sixth or seventh day the sutures may be removed; but if good union has not taken place and they are not causing irritation, they may be left in position for a longer period.

During convalescence the vagina should be kept well cleansed by the daily use of some antiseptic lotion.

In recto-vaginal fistula the bowels should be kept locked up for ten days or a fortnight, till the wound has firmly united, and then the feces should be rendered soft by enemata of oil and gruel.

When the tissues around the edges of the fistula are too thin to allow of their being pared—and, indeed, under some other circumstances—they may be split; that is, the vaginal mucous membrane may be raised from its submucous bed for half or three-quarters of an inch round the fistula and the under-surfaces of the raised membrane brought together and held there by a quill suture. I have adopted this method on many occasions and been most favorably impressed with its advantages. I was led to do so some years ago in a case of vesico-vaginal fistula where there was no tissue to spare, and was pleased subsequently to see so good a surgeon as the late Mr. Collis of Dublin make the same suggestion. When this plan is adopted, the sutures must be removed on the fourth day, otherwise, the pressure of the bougie may cause ulceration. At times it is best only to cut the sutures and leave the quills in position for a day or so longer, the amount of irritation they cause being the surgeon's guide. Dr. Kidd and Mr. Mapother of Dublin have adopted, however, what appears to be a better practice. They make a U-shaped cut round the fistula through the mucous membrane of the vagina, raise the flap thus formed, and cut off its lower half, including the opening of the fistula into the vaginal mucous membrane. They then draw down the shortened flap over the fistulous opening into the bladder and unite it by sutures to the crescentic border of the mucous membrane forming the bed from which the flap had been raised. The fistulous opening into the bladder is thus covered over with a flap of sound mucous membrane (*Brit. Med. Journ.*, June, 1872).

When the neck of the uterus is involved in the fistula, it may be necessary to lay it open; but when the uterus is involved, it is more frequently necessary to turn the neck of the uterus into the bladder and close the vagina high up. In very extensive lacera-

tions of the vesico-vaginal septum the surgeon may be called upon to close the vagina nearer its orifice. I have done so on several occasions with good success, two or more operations being required.

When the fistula is surrounded by cicatricial tissue, and after the coaptation of its edges there is found to be much tension, lateral incisions through the tense mucous membrane are of great use in allowing the edges to fall rather than to be held together.

In recto-vaginal fistula unconnected with parturition, before an operation is attempted the surgeon should satisfy himself by a digital examination of the rectum that no stricture or disease of the rectum coexists to which the fistula is secondary.

Vascular excrescences are very common in the female urethra, and from their great sensibility cause severe pain. They at times project from the meatus as a florid outgrowth and are often attended with a discharge of mucus, and at times of blood, also with irritability of the bladder. Their removal is the only sound treatment, and this can be effected by forceps and scissors or by means of the galvanic cautery. When the former practice is followed, the growth should be well drawn downward and excised, a stick of nitrate of silver being applied to the base of the tumor, to prevent bleeding. When any doubt exists as to its complete removal, chloride of zinc may be used.

When the urethra is the seat of more than one such growth, the introduction of a stick of sulphate of zinc at intervals of two or three days may be followed by the withering of the growths; but when this result does not ensue, the passage must be dilated and the growths removed. Nitric acid in some cases is a good caustic to ensure their destruction when excision or the galvanic cautery cannot be employed, and Dr. A. Edis recommends (*Brit. Med. Journ.*, April 4, 1874) the saturated solution of chromic acid, to be applied by means of cotton-wool rolled round a stick to the growth until the surface becomes shrivelled.

To facilitate the use of any of these means, but more particularly the destruction of the growth with the galvanic cautery, I have found the use of the boxwood or ivory speculum and dilator (depicted in Fig. 438) of great use. By it the urethra can be readily dilated, the urethral growth made to project through the aperture left in its side, and the whole tumor destroyed without doing any injury to the healthy tissues.

FIG. 438.

Speculum Dilator for Female Urethra.

Polypi of the female bladder may protrude through the urethra and put on the appearances of a urethral growth, but a complete examination of the urinary organs will prevent the surgeon falling into any error of treatment.

Fibro-cellular tumors at times grow in the urethra and cause much local distress. Some years ago I removed one which occupied the whole floor of the urethra to the neck of the bladder from a lady with a good result.

Irritable bladder in women is a very common effect of uterine disturbance or displacement, as well as of rectal disease. Such a symptom demands the closest investigation to ascertain its cause. It is mostly secondary to disease of the uterus, etc., and not often dependent on bladder affections. When difficulty in diagnosis is experienced, the surgeon should without hesitation make a digital exploration of the bladder.

CHAPTER XXVI.

DISEASES AND TUMORS OF THE BREAST.

Sore nipples are sources of great distress and too often the precursors of mammary abscess. They are doubtless often caused by some aphthous condition of the child's mouth, but they as frequently result from some unusual sensibility of the skin of the part, and at times from want of care. In first pregnancies mothers should always harden their nipples by the daily use of some spirit lotion or eau de cologne and water, and where they are not sufficiently prominent a breast glass or gutta-percha shield should be worn, as nothing tends more than these means to prevent this troublesome affection.

TREATMENT.—When sore nipples occur at the time of suckling, the same shields

should be worn, great care being observed to dry the nipples after use and never to leave them in the child's mouth after the process has been completed. The application of the glycerine of tannic acid, Richardson's styptic colloid, tincture of catechu, a solution of nitrate of silver gr. v to the ounce of water, and an ointment of extract of rhatany gr. viiij mixed with ʒij of the oil of theobroma, are good applications. Castor oil as an external application, or collodion, is sometimes useful. When cracks exist, it is a good plan for the mother to draw out the nipple by means of the old-fashioned feeding-bottle before giving it to the infant, the mother's nipple being put into the central opening and her mouth drawing the artificial one. Another ready method is the application to the nipple of the mouth of a wide-necked empty bottle that has been heated by hot water, the nipple, as the bottle cools, being pressed into the bottle and rendered prominent in a painless way.

Engorgement of the breast takes place when from any cause a woman is unable to give suck, either from defect or disease of the nipple or from the death of the child. Under these circumstances the gland may become tense and distended, and if left unrelieved for twenty-four or thirty-six hours will probably inflame. When the gland, however, can be relieved by the application of an infant to the nipple, or, next best, by a bottle in which a partial vacuum has been made by means of hot water, the mother's mouth, or a *very carefully* applied breast pump, the engorgement may subside and no harm accrue.

Pressure should then be employed by means of strapping, which must be applied over the gland, previously smeared with the extract of belladonna rendered liquid with an equal part of glycerine. A saline or other purge is often of value, with some tonic medicine as quinine, a mixture of two or three drachms of the sulphate of magnesia and one or two grains of quinine two or three times a day being as good as any.

In lobular engorgement of the breast gentle friction is of great value, with or without oil, and warm and moist applications are also most useful.

INFLAMMATION OF THE BREAST.

This may appear as either a *subcutaneous* more or less extensive periglandular abscess, a *local* phlegmonous lobular inflammation, or a *diffused* abscess throughout the whole gland. It may primarily involve the connective tissue which exists between the lobules, as well as the true secreting structure of the gland; it may likewise occur behind the gland.

It may be *acute* or *chronic* in its nature; it may run its course without any breaking up of tissue or suppuration or be attended with most destructive local results, the extent of destruction of tissue depending upon the severity of the inflammatory process and the amount of constitutional power of the subject of the disease. As a rule, however, suppuration takes place.

"When the mamma, in its state of full expansion and perfect functional activity, becomes the subject of an interference, the result is very commonly a diffuse or nodular inflammation and the formation of an abscess. A sudden stoppage of the milk soon after the lactation has been established is apt to produce inflammation, and the same result, or a degree of it, sometimes follows the weaning of the child after a long course of suckling. The disturbing cause, whatever it may be, acts upon the mamma when its function is at its greatest intensity, and the characteristic effect is inflammation and abscess" (Creighton).

In a general way, inflammation attacks the breast gland when in a state of activity, and it is exceptional for the passive organ to be the subject of this process. Out of 102 consecutive cases under my observation, 79 occurred during lactation, 2 during pregnancy, and 21 in patients who were neither suckling nor pregnant. Three-fourths of the cases that occurred during lactation attacked patients during the first two months, and in many of these a cracked nipple was the assigned cause; but I am disposed to think, with Mr. Ballard, that abscess in the early months is due to the searching of the child after milk before the gland is filled in patients who have not sufficient power either to secrete milk or to resist the inflammatory process when once originated. The affection is more common in primiparæ, and the right breast is more frequently affected than the left in the proportion of 5 to 3. In some cases the rapidity of the process is very marked, an abscess forming within a few days, while in others it is most insidious; chronic abscesses have been often mistaken for new growths, and amputation of the gland performed under this false diagnosis.

Abscesses occur in *infants' breasts*, and they are too commonly the consequence of an ignorant nurse applying pressure to the glands in which milk is found or friction to "rub away the milk." The milk appears to be more abundant in the male than in the female infant.

They are also met with in the male subject from injury or other causes.

Chronic mammitis in the boy or girl is by no means a rare affection, the undeveloped gland becoming indurated and very painful; such cases rarely suppurate.

TREATMENT.—The activity of the treatment of the affection we are now considering must be regulated by the acuteness or severity of the inflammatory process and the nature of the constitutional and local symptoms to which it may give rise. As a broad truth it may be confidently asserted that the inflammatory process is of a low type and of a destructive nature, and that, as the constitutional powers are generally feeble, nothing like lowering measures should be adopted, but, on the contrary, soothing local applications and constitutional tonics with sedatives are absolutely demanded.

In cases occurring during lactation no other principles of treatment than those I have just laid down should be entertained. Under such conditions soothing fomentations to the breast, either of warm water or of some medicated solution such as the decoction of poppies, give most relief, although a light linseed poultice or some spongiopiline may be well employed. In young, robust women, where suckling is impossible, the application of laxatives and powerful purgatives may be called for.

Rest in the horizontal position affords striking comfort, and when it can be carried out is of great practical advantage; but if this desideratum cannot be secured, the whole breast must be supported by a band or linen sling. During this time tonics in such a form as can be borne and may be indicated should freely be given, quinine probably being the best. Such stimulants as wine and beer must be cautiously administered, though the cases are few which do not require such an addition to their diet, while plenty of nutritious food should be allowed. A sedative at night is also very generally required, and Dover's powder in ten-grain doses is the best form; for want of sleep from pain is a common accompaniment. A mild purgative in the early stages of the disease may be necessary, but excessive purgation should be avoided, since the object of the surgeon is to supply power, and not to remove it—to soothe, and not to irritate.

Opening a Mammary Abscess.—There is a great difference of opinion among surgeons about the propriety of opening a mammary abscess. Some think the best practice is to let the breast alone and leave the operation to nature, while others advocate an early opening. But in neither am I disposed to coincide, for, while I regard it as a right practice to postpone puncturing the organ as long as possible and not to show any overanxiety in evacuating the pus, on the other hand I know that when the abscess is left to itself much unnecessary suffering is endured and a considerable sacrifice of skin often follows, entailing a long convalescence and an ugly cicatrix. The practice I consequently generally adopt is to leave the parts alone till pointing has taken place and then to puncture, making my incision in a line radiating from the nipple of the patient. By adopting this practice any unnecessary pain is saved, for the appearance of pointing is directly under the observation of the surgeon, and it is not necessary to make frequent and careful physical examinations. Of course some gentle manipulation is absolutely called for to enable the surgeon to form an opinion, but the eye, not the finger, is the chief guide. Much manipulation of the gland is both painful and injurious, and an absolute abandonment of all local surgical treatment can only be condemned.

Warm fomentations in all stages of the disease are very grateful to the patient and may be freely used; and when early suppuration threatens, a light linseed poultice is probably the best application. When the abscess has discharged, the poultice may be laid aside and some antiseptic application employed, as constant poulticing soddens the integument and retards the process of convalescence.

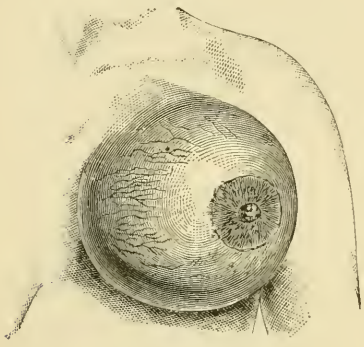
Treatment of Chronic Abscess.—The existence of a chronic abscess having been made out—a point, by the by, which will be returned to when the subject of the diagnosis of a mammary tumor is discussed—it becomes an important question what treatment should be pursued.

When the abscess is small, causing little or no annoyance, it may be left alone, and under the influence of tonics and local pressure by means of strapping the fluid may be absorbed, and such a result is occasionally brought about. In the majority of examples, however, some more active treatment is necessary, and of these the evacuation of the pus is the chief point. If the abscess is large and deeply seated—a common condition—the drawing off of its contents by means of a trocar and canula is the usual practice and is

generally believed to be the best; but it has this disadvantage—that the wound generally soon closes and a second operation is required. The same treatment may be again resorted to, with the same results, and this drawing off of the pus and the subsequent closure of the wound may go on for many times. At last, however, the opening remains patent and the abscess contracts, leaving a sinus in the majority of cases. Under these circumstances a bolder plan of treatment seems absolutely demanded, as time is an important element in the consideration of any plan of treatment. The best method appears to be a free opening at the first operation, the surgeon subsequently inserting a strip of oiled lint into the cavity of the abscess for a few hours, to prevent the wound closing.

Submammary Abscess.—Abscesses occasionally form *behind* the breast gland over the pectoral muscle; and when they do, the gland is pushed forward in a way that is characteristic. The abscess (Fig. 439), as a rule, points below the breast. Such abscesses should be opened in the most dependent position as soon as any indication of fluctuation can be made out. This disease is very slow in its progress.

FIG. 439.



Submammary Abscess.
(Drawing 401[3], Guy's Mus., Birkett's case.)

Treatment of Sinuses.—The treatment of sinuses in the breast, as elsewhere, is always a task of difficulty, and in certain cases all plans will fail. The one principle of practice which seems to be the most valuable is the establishment of a dependent outlet, and for this purpose the introduction of a drainage tube is a simple and successful practice. If there are many sinuses, some pressure may be employed by means of strapping, care being taken that the openings are left uncovered, to ensure a free passage for the discharge. Superficial sinuses may be slit up when other means fail, and in very chronic cases some irritant such as iodine may be injected, to excite a fresh action. The great principle of practice in these cases, however, appears to be that to which I have already alluded, although other means may at times be demanded.

CHRONIC INDURATION OF THE GLAND.

This affection occurs when, from some cause or other, the gland is morbidly excited. It is chiefly found in unmarried women between the ages of thirty-eight and forty, though it occurs in the married, and then, as a rule, in the sterile. It is usually associated with some catamenial irregularity or some general disturbance, more particularly of the nervous system.

SYMPTOMS.—The affection is known by the excessive sensibility of the indurated gland on manipulation, the nervous excitement the examination causes, *the total absence of any local indications of a tumor when the fingers are placed flat upon the part*, and the induration of the gland or lobe of the gland when the organ is raised from the pectoral muscle and pinched.

TREATMENT.—The treatment consists in correcting what is wrong in the general condition of the patient by means of iron, tonics, and alteratives, and soothing the affected part. Cold lotions are at times grateful, while at others a belladonna plaster affords relief, with or without pressure. Large breasts should be suspended, and all should be protected by cotton-wool from the risks of injury.

The **irritable mamma** of young girls is closely allied to the affection just described, and is associated with a morbidly sensitive condition of the mammary gland and parts around, and often with some induration. It is an affection closely connected with the pelvic generative organs, which are mostly found to be not acting fairly, as indicated by catamenial irregularity, etc. This condition is doubtless at times excited by depraved habits. It should be treated on the same principle as the last affection.

TUMORS OF THE BREAST.

Tumors of the breast may rationally be accounted for by following out the functional aberrations of the organ, and in proof of this the student should study carefully the highly suggestive and valuable work of Dr. Charles Creighton,[1] who has shown that "the

[1] *Contributions to the Physiology and Pathology of the Breast* (1878).

investigation of breast tumors reveals merely the working of the physiological law of healthy mammary activity under altered circumstances, that various degrees of disordered function may result in various kinds of tumors," and that tumor disease of the breast is "essentially a disorder of function."

The breast, in passing from its "resting" or inactive state to that of full activity, undergoes during the entire period of pregnancy a process of "evolution," which is characterized in its different stages by certain cell changes within its acini and transport of cells without, and in the return of the gland to its quiescent condition, on the subsidence of lactation, a process of "involution," in which a parallel series of changes acting in an inverse order is to be observed, the functional subsidence of the gland being spread over a shorter period of time than its gradual awakening during pregnancy.

When the functional stimulus of the mamma is acting at its *lowest* point at the beginning of "evolution" or the ending of "involution," the secretory products are large granular yellow pigmented cells, which are found within the secreting acini, in the connective-tissue spaces outside the secreting structure, and likewise in the lymph sinuses of the subjacent lymphatic glands, these cells being the waste products of a feeble degree of secretory activity; and if the mammary excitation were always to act at that degree of intensity, the secretion, it may be said, would always be in the form of large granular pigmented cells.

At the *next appreciable advance* in the intensity of the stimulus the product formed in the gland may be described somewhat generally as a large granular nuclear cell, which is nothing else than the crude epithelium of the middle period of the breast's unfolding, in which an imperfect secretory force resides.

Coming *still nearer to the full excitation*, the cellular ingredients are fewer and the mucous production much more abundant, and finally, when the *stimulus is at its height*, the mucous fluid has given place to a fatty fluid, and whatever cellular elements the secretion contains are the well-known colostrum cells, which approach most nearly the perfect secreting cell. The periodical unfolding of the breasts, which is an obvious accompaniment of each pregnancy, is thus characterized by a progressive series of immature secretory products, which necessarily run to waste. The epithelial cells are not transformed into milk till the time of delivery and during the period of suckling following, but the functional action of the breast has been at work all through the pregnancy, and has advanced in intensity just as the secreting structure has advanced in its unfolding. The various stages of unfolding have corresponding secretary products, becoming less and less crude, and, as there is a similar series of more rapid but exactly parallel waste products in the upfolding, it is a legitimate inference to ascribe "a special kind of secretory product to a certain degree of intensity of the glandular force."

When the breast gland is disturbed from its resting state by a cause other than pregnancy, and in consequence of some morbid excitation is urged into a kind of evolution process, the steps of its unfolding are less orderly than in the normal evolution, and the "spurious excitation" never carries the gland to the end of its unfolding or to the perfect degree of its function. And, although the morbid excitation may be said to correspond in its intensity to a stage of the normal evolution, there is this fundamental difference—that the corresponding stage of the normal process is transient, giving place to a stronger force, while the morbid process continues indefinitely at the same enfeebled level. As a consequence the cell that should have been thrown off from the acinus as waste almost as soon as it was formed, remains in the place of its origin to multiply and with its progeny to infest the glandular structure of the breast as either intra- or extra-acinous accumulations. Indeed, according to Dr. Creighton, it is upon deviations from the physiological track such as these that the existence of a tumor depends.

Thus, "a circumscribed tumor arises at a particular part of the gland where the spurious excitation has advanced to a certain stage of evolution or unfolding; in that particular region, probably a territory defined by the blood vessels, the functional force has acted at a uniform imperfect level for a length of time, the inevitable cellular waste of the crude secretion has accumulated within the acini or around them, and the foundation of a tumor has been laid.

In the healthy action of the organ there is a provision for the disposal of the very considerable amount of cellular waste material by means of the neighboring lymphatic glands. In passing from the secreting acini and in traversing the stroma of the gland the waste cells often acquire a spindle form, and, although these cells are not always distinguishable from the connective-tissue cells of the part, there is, especially in the bitch, a class of pigmented epithelial cells in which such changes of form and position

can be clearly traced. The spindle-shaped waste products are the type of the peri-acinous cell collections in cystic or adeno-sarcoma.

So far as relates to the large nuclear cells, the *intra*-acinous collections of them correspond to the structure of medullary cancer, and the *extra*-acinous infiltrations of the same cells are a distinguishing feature of scirrhus. "The distinguishing feature of the less malignant form of tumor is that the spurious *functional* activity comes nearer in the degree of its intensity to that of the perfect secretory *force*, the transformation of the epithelium is a more real transformation, and the cellular waste is reduced—in part, at least—to the class of fibre-like or crescentic elements that characterize the myxomatous and more benign issues of the tumor process."

"The circumstance that the unknown diseased excitation most commonly befalls the gland when it is in the state of rest is of the first importance in accounting for the formation of a tumor. Whether the distubance be a mechanical injury or a sympathy with excitement in the ovaries, or of a more general emotional nature, it comes upon the breast in its resting state. The breast can react in no other way than by following the somewhat slow process of its normal evolution; without the intermediate stages of unfolding, it cannot reach the perfect degree of its functions in which there would be immunity from danger. The intermediate stages are necessarily associated with the formation of crude cellular products; it is at one or other of the intermediate stages that the morbid force delays, and the corresponding cellular secretion of the gland thereupon assumes the character of a formative or tumor process."

"The circumstances of the functional disturbance are never exactly the same in any two cases; consequently, the respective modifications of structure—or, in other words, the structure of the respective tumors—are never exactly the same."

When a tumor forms in the breast within the period when the function may still be awakened to its full and healthy vigor—that is, during the period of its structural and functional maturity—a resolution of the disease or a dispersion of the diseased products may be looked for; but when it appears at or near the climacteric years, when the gland is suffering an effacement of its secreting mechanism and a withdrawal of its secretory force, no such a result can be expected, and it is at this period that the greater number of intractable tumors occur.

"It is the climacteric effacement of the breast that gives a peculiar character to the disease in women, and there are well-marked structural differences in the tumors according as they appear before or after that period. Those that develop after the climacteric years are perhaps the most common, as they are certainly the most intractable, and they have been the real source of ambiguity in the pathology of the organ. That ambiguity depends upon the circumstance that they occur in an organ which is gradually losing or has lost its characteristic structure." Where the normal itself is vanishing, the departures from the normal are elusive.

It seems probable, therefore, from Dr. Creighton's investigation, that the adenomata, sarcomata, myxomata, and carcinomata have their type in a series of progressive changes which the gland undergoes in its physiological evolution. The feebler the intensity of the function, the more cancerous the disease; the higher or more advanced the evolution from the resting state, the more benign the tumor.

Clinical Examination and Diagnosis of a Breast Tumor.

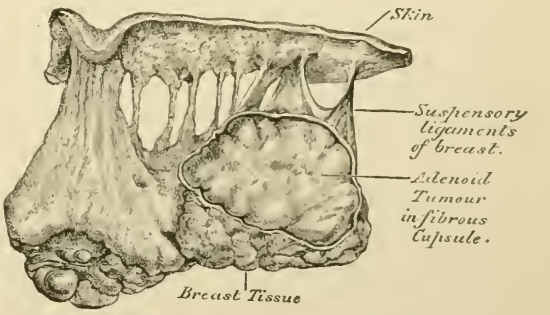
From a practical point of view, tumors of the breast may be divided into *inflammatory*, *adenoid*, or innocent, *cystic*, *sarcomatous*, and *cancerous*. Simple hypertrophy or excess of growth of the gland can hardly be classed among the tumors.

The first point a surgeon has to determine when consulted by a patient who has "something the matter with her breast" is practically the existence or non-existence of a tumor —*i. e.*, is there a new growth developed behind and in connection with the mammary gland or is the disease from which the patient is suffering situated in the substance of the glandular structure itself? This first and most important question ought to be solved before a further step can with safety be taken, before the formation of a correct diagnosis of the case can be made; and it is quite impossible to magnify its importance. To do this, however, considerable care is necessary, and some manipulative skill must be called into requisition, as a careless examination will surely end in an uncertain diagnosis, and with this a failure in treatment. In examining a breast, therefore, with diagnostic intentions the surgeon, with the whole gland well in view, should place the palmar surfaces of his fingers over the suspected spot, and, taking the gland in his hand, manipulate it gently

and in every part with his fingers and thumb, when, if an isolated tumor can be found, he will in all probability detect its presence. If, however, he is uncertain upon this point, he should make the patient lie down; for "if a patient be sitting or standing and the breast is grasped by the finger and thumb, when induration of the gland itself exists a sensation is felt as if a tumor were present. If now the palmar surface of the fingers be pressed flatly against the chest in the same part, nothing remarkable will be distinguishable. If a tumor or new growth exists, however, it is immediately perceptible. But if a doubt arise in the matter, the patient should recline when under examination, and then, if there be a tumor, it is immediately manifest to the touch, and often to the eye (*Birkett*). Having, then, detected the presence of a tumor—that is, an independent growth developed in the neighborhood of the breast gland, and probably in connection with it—the question arises as to its nature. Is it a simple or a malignant tumor? If the tumor be movable and hard, if quite free, or if it has but a very uncertain connection with the gland structure, there is a strong probability that the tumor is of a simple nature; and if it has existed for several months, this probability becomes stronger, for the *cancerous* tumor has a tendency, even when primarily developed as a tuber or as an independent structure, to associate itself and become connected with the neighboring tissues by an infiltrating process; and if this has not taken place, the absence of these conditions enhances the probability of the simple nature of the growth under examination. If the patient is also young and healthy and no other abnormal conditions of either the breast or the neighboring structures are to be detected, the probability becomes a certainty, and the presence of an "adenocele" may be determined on, this tumor being synonymous with the chronic mammary tumor of Sir A. Cooper, the mammary glandular tumor of Paget, the sero-cystic sarcoma of Brodie, the adenoma of Birkett, or the fibroma of Gross.

These *adenoceles* are found as a rule in the young and unmarried and in the apparently healthy and robust, although occasionally they occur in the aged. They appear during the period when the procreative organs, and among them the mammary glands, are in a state of "developmental perfection;" and when they occur in married women are most frequently developed during pregnancy or suckling. They are never associated with any other symptoms than such as can be produced mechanically by their presence, and never involve the integument except by distension, nor is the skin ever infiltrated by any new material. They are never accompanied by any secondary enlargement of the absorbent glands or associated with any secondary deposits; they cause no cachexia and do not undermine the health, but affect the patient solely through local influences, and demand treatment chiefly from local considerations. They may be found in either breast, occasionally in both, and are constantly multiple, two or more tumors being often found in the same gland. In Fig. 440 the way the growth attacks the gland as an encapsuled tumor is well illustrated.

FIG. 440.



A Succulent and Fibrous Mammary Glandular Tumor and Cysts of Six Years' Growth. (Taken from S. A. P——, a single woman æt. 26. The drawing exhibits a section of the new growth and a piece of mammary gland. The growth is enveloped by a fibrous capsule continuous with the suspensory ligaments of the breast. Prep. 22925, Drawing 410^{50}, Guy's Museum. J. Birkett.)

From my notes of 81 cases consecutively observed—

22 appeared under the age of 20.	2 above the age of 50.
28 between 21 and 30 years of age.	37 were in single women.
18 " 31 " 40 "	31 in the married and prolific.
11 " 41 " 50 "	12 " " " sterile.

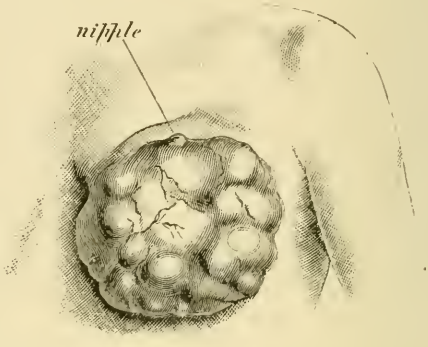
As long as these tumors remain small and quiescent they are of little importance, and, being movable, are readily diagnosed; but when years have been allowed to elapse and their growth has increased, and from their greater size they have become burdensome and press on neighboring structures, they are neither of small importance nor readily to be distinguished. But yet, if careful observations are taken, an error in diagnosis should not be made; for, although the breast itself may be much pressed on, or even

expanded over, the tumor, it will still exist, and on careful examination its presence, as a rule, will be made out. The nipple, although flattened from the extreme glandular expansion-can still be seen (Fig. 442) and is rarely retracted. The integuments may be stretched to an extreme point, yet they will still be movable and sound (Fig. 441),

Fig. 441.

Cystic Adenocele.

Fig. 442.



Solid very Lobulated Adenocele of Six Years' Growth. (Taken from A. S——, æt. 35.)

although some inflammation from overdistension may have made its appearance, and large veins are always to be observed meandering in the healthy tissue. The tumor, if solid, may appear lobulated (Fig. 442); and if containing cysts, fluctuation may be detected. Still the disease is essentially a local one and affects the patient through purely local conditions. It is to be treated only by excision, and the gland, as a rule, should be left unharmed, the tumor being turned out of its capsule. In extreme examples, however, the breast is so stretched out as to be useless, and then must be removed. In the patient from which Fig. 442 was taken this was the case. She was a woman æt. 35, and the tumor was of six years' growth.

Diagnosis of a Tumor evidently caused by some Partial or General Enlargement or Infiltration of the Mammary Gland.

Let us suppose that the surgeon has a case of disease of the breast before him in which the structure of the gland is itself involved, and there is no independent movable tumor such as we have been considering, but in which on manipulation it is evident the growth, whatever it may be, is intimately connected with the gland structure.

Fig. 443.

Hypertrophy of Breast.

What is the case? Have we an inflammatory affection only of the organ, or some hypertrophy or innocent enlargement? Is it a simple or a malignant disease? When the manipular indications of the mammary gland are those only of enlargement, is such a condition due to pregnancy or the product of a simple hypertrophy, confining the meaning of that term to an excess of growth?

If the increase be due to hypertrophy—which is a somewhat rare condition—it will have been to a certainty of a chronic nature, its increase slow and growth painless. The gland will appear simply enlarged, with no increase in action beyond that which growth demands, although this increase in growth may be very great. It is found mostly in young women, but I have seen it in the male; at times it affects only one gland. In the case from which Fig. 443 was taken each gland on removal weighed about fourteen pounds. I saw the case some years ago with my friend Mr. Shipman of Grantham. The breasts were subsequently removed by Sir W. Fergusson.

That the affection is something more than a mere increase in the growth of the gland is proved by the fact that in a female patient of mine æt. 43 who had this disease, of thirteen years' growth, in her right breast, and not in her left, and had a child, no milk was secreted in the diseased gland, while in the sound one there was abundance.

If the enlargement be due to pregnancy, there can be little difficulty in the diagnosis; for it is attended with an activity of the local circulation, a general fulness of the gland, an enlargement of its veins, and a darkening of the areola which will not fail to excite suspicion. Besides this, *both glands* will be similarly affected—a coincidence which is rarely seen in any morbid condition. The very suspicion of pregnancy, however, will be enough to call attention to other points by which a solution of the difficulty can be obtained.

Is the enlargement to be explained by any inflammatory condition? I do not mean an acute inflammatory condition—for such an affection has features which are too characteristic to allow any mistake in diagnosis being made—but is the infiltration of the gland to be explained by some chronic inflammatory change such as is so frequently found in the female breast, or is it the early stage of an infiltrating cancer? The answer to this query is not always easy. In middle-aged patients, when cancerous affections may be looked for, the presence of an indurated mammary gland, wholly or in part, must always be regarded with suspicion; and if the case be recent, I believe it to be an impossibility to form any certain opinion as to its true nature. If the induration of the gland be the only symptom and is associated with a sharp, or even a dull, pain, either a simple chronic inflammation of the gland may be indicated or the early condition of a cancer. If, however, much time has already passed—say many months—and no other symptoms have made their appearance, there is some ground for the hope that the enlargement may be due to inflammation, since infiltrating cancers are not generally inactive—are not stationary, as a rule—and soon give rise to other symptoms, such as some, though it may be slight, enlargement of the absorbent glands, some slight dimpling or puckering of the skin—an important sign—or some more marked symptom, such as infiltration of the integument or a retracted nipple. It should be remembered, however, that a retracted nipple is only an accidental symptom such as may be caused by several conditions, and is not by any means of itself characteristic of cancer. But if any or all of these symptoms show themselves soon after the first appearance of the lobular enlargement of the mammary gland, an opinion as to the cancerous nature of the growth may be confidently expressed. If, on the other hand, none of these symptoms make their appearance and the induration or infiltration of the lobes of the gland remains stationary or shows some tendency toward improvement, the probability of the simple character of the disease gains ground. When this induration of the mammary gland appears in a *young subject*, there will be no reason to suspect a cancer, and it should rather be regarded as the result of some slight inflammatory effusion. Under such circumstances there will generally be some increase of pain after examination, but an absence of any other local symptom. There will probably be some irregularity of the catamenia and some signs of general excitability of the patient. But, as a local affection, there will be only the one symptom of induration of one or more lobes of the mammary gland, which, *in the absence of all other signs*, may with safety be regarded as inflammatory. The same argument holds good when the disease appears at a later period of life, although suspicions of a cancer should rightly be excited; still, the positive diagnosis must be postponed till by the lapse of time some other symptoms, such as those already mentioned, make their appearance to clear up all doubt, or by their absence prove the innocent nature of the affection.

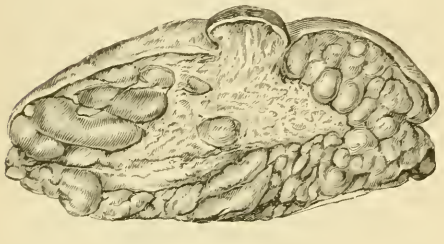
Carcinoma of the Breast, or Cancer.

This affection is found either as an *infiltration* of the gland, wholly or in part (Fig. 444), or as an independent tumor or tuber within the meshes of the gland—*tuberous cancer* (Fig. 445). It may likewise be met with associated with cysts—*cystic cancer*—this being only a variety of the other forms.

In the infiltrating form the gland appears hard, inelastic, and incompressible; as the disease progresses it seems to contract and to draw all the parts around together, and gradually to infiltrate them. In this way the nipple often becomes drawn in or to one side. At times, after having been drawn in, it becomes infiltrated with the disease and becomes again prominent; at others, by the contraction of the gland, it may be strangulated, become œdematous, and then slough off. The skin is at first dimpled, then puckered, and at last infiltrated. The breast also, from being a movable organ, becomes fixed—so fixed, indeed, that it cannot be separated from the pectoral muscle.

This form of cancer is the more common. The disease may appear in one lobe or in all and be slow in its progress or rapid, but in all cases its progress is much alike.

Fig. 444.



Infiltrating Cancer of the Breast.
(Drawing 409[18], Guy's Mus., Birkett's case.)

Fig. 445.

Tuberous Cancer.
(Birkett's case.)

Tuberous cancer commences as a circumscribed independent growth within the gland structure, with a well-defined capsule separating but not infiltrating the tissues (Fig. 445). Sometimes two or more tubers appear together, and these may at last coalesce. This form, unlike the infiltrating, does not contract, but grows in all directions, involving all the parts which it touches, pushing the breast to one side, or drawing it to itself. It often attains a large size, giving rise to an irregular lobulated tumor. It is at times soft in consistence, when it is called *medullary* cancer; when firm, it is known as *fibrous;* when jelly-like, *gelatiniform;* and more rarely it is black, or *melanotic*. As it grows forward it may involve the skin, break, and ulcerate, giving rise to the appearances formerly called *fungus hæmatodes*, this form being always accompanied with hemorrhage.

In both forms the lymphatic glands in the axilla, above the clavicle, or on the side of the neck will sooner or later become involved; and when the skin is implicated, this symptom soon appears. As the glands enlarge nerve pains down the arm appear and œdema of the arm commences, from the mechanical obstruction to the venous circulation of the extremity caused by the enlarged glands. At times a serous effusion takes place into the pleural cavity of the affected side sufficient to destroy life.

In some rare cases of cancer the disease appears as a *brawny* infiltration of the breast and integument over it, some erythematous redness and œdema being mixed with it at its onset. These cancers are of the worst kind and speedily destroy life.

In other cases, mostly chronic, the disease is more cutaneous and shows itself as a tubercular affection of the skin, which gradually spreads till at last the part affected seems skin-bound. This condition may be limited or extensive and occasionally involves the whole of one side. I have recently had a case under observation in which both breasts, the sternum, sides, and half the dorsal region of the back were thus involved. At times this tubercular development is associated with acute or recurrent disease. In rare examples it occurs as a primary affection and is very chronic, the tubercles even disappearing by atrophy.

A *cancerous tumor* of the breast most frequently appears in middle life—that is, when the procreative organs are verging toward their natural period of functional decline, such a period taking place at an earlier date in the single than in the fruitful woman. It attacks married women more frequently than the unmarried, and when infiltrating or involving the breast gland is seldom stationary.

As the disease progresses unchecked ulceration of the integument, preceded by a softening down or breaking up of the tumor itself, will soon appear, and with this the characteristic infiltration of the margin of the wound will occur and give rise to indurated, everted edges (Fig. 449). A general cachexia, from the pain and wasting discharges, will soon show itself, and more or less distinct evidences of the complication of other organs, become apparent. Under such circumstances the end is not far off, for the disease has run its course, and with it the powers of its victim have become undermined; for the victory remains with the strongest. In a general way, a cancer runs its course in two or three years, though sometimes it is most chronic in its action.

To illustrate some of the points connected with this subject, the following analysis of 400 cases may be of value. The cases are taken from my own notes: 180 occurred in Guy's during the period of my registrarship, many years ago, and 220 are from my own case-book since.

The disease made its first appearance—

In	17	cases, or	4	per cent.,	under 30 years of age.			
"	108	"	27	"	between 31 and 40 years of age.			
"	144	"	36	"	"	41	" 50	"
"	101	"	25	"	"	51	" 60	"
"	29	"	7	"	"	61	" 70	"
"	1	over 70 years of age.						

I have, however, seen a case of cancer of the breast in a patient aged 28, and one of a year's standing in the breast of an old lady æt. 96.

Of these 400 cases, 313 were married, 77 single, and 10 were widows.

Of the 313 married, 235 were prolific and 78 sterile. A large proportion of the prolific women were so to an extreme degree, ten and more children being a common note to find recorded. Married women and those in whom the gland has been the most active are apparently more liable to cancer of the breast when the period of gland activity has passed than the single.

Of these examples, 194 were in the right breast, 187 in the left, and 19 in both. In 140 the disease had existed a year or less;

In 99 between 1 and 2 years.					In 13 between 4 and 5 years.			
" 23	"	2	"	3 "	" 9	"	5	" 7 "
" 15	"	3	"	4 "	" 6	"	8	" 9 "

In 4 cases the disease had existed ten, twelve, fourteen, and twenty years respectively, and the form of cancer in these of long standing was the atrophic.

With respect to any *hereditary history* of cancer in the 400 cases, although carefully inquired into, I found it to exist in only 47, or nearly twelve per cent. In 35 of these cancer was reported to have occurred in one member, in 11 in two members, and in 1 in three, of the patient's family.

In 7 of the 47 cases the relative was on the father's side, in 23 on the mother's, and in 7 it was found among the brothers or sisters. In 5 it had attacked the aunts, in 3 cousins, and in 1 a grandmother, although in these the point was not stated respecting the paternal or maternal relation. These facts are enough to indicate that where an hereditary tendency exists it is more powerful on the mother's than the father's side.

In a large proportion of the cases in which an hereditary history of cancer was traced the cancer was of the breast.

A section of an infiltrating cancer is well shown in Fig. 444: a section of the tuberous form in Fig. 445. For the microscopical appearances of cancer, *vide* Fig. 45.

Colloid or **alveolar cancer** is occasionally seen in the mamma, although in a clinical point of view the growth presents no such features as to enable the surgeon to recognize its presence. In Fig. 36, page 138, a cancer of the kind is illustrated. In it the clinical features of the affection were those of the cystic disease. It is found in the gland as an infiltrating and tuberous growth.

To the eye the colloid disease has a peculiar aspect, its jelly-like, semi-transparent material, of all tints of pink and red, from degrees of blood-staining, being divided by thin meshes of fibre tissue into cells of different sizes. The way the jelly-like structure oozes from its cells and the slight changes that take place in it after immersion in spirit are its chief characteristics.

It ought to be treated by excision of the whole gland.

Cystic Tumor of the Breast.

The **simple sero-cyst** is usually found single in the mammary gland, and appears as a small hard lump in one spot, which is at times, but not often, painful. As it increases it becomes more globular and dense, sometimes being of a stony hardness, while at a still later date it may afford the sensation of fluctuation. If left alone, it may so enlarge as to come forward, and even burst, discharging a thin watery *non*-albuminous fluid and then collapsing. In rare cases the disease is thus cured, but more commonly the fluid reaccumulates.

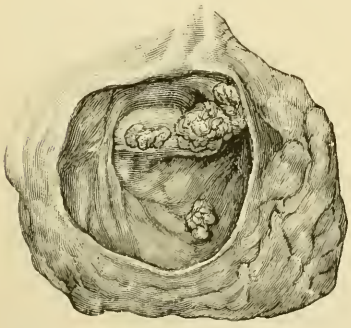
"The cyst wall of this tumor," writes Birkett, "is very thin, composed of fibre tissue firmly attached to the surrounding parts and lined with squamous epithelium. It is always perfectly closed, and never communicates with a duct."

Treatment.—Such cysts should be punctured with a trocar and canula and some cold lotion applied, for by this means many are permanently cured. Brodie employed

alone, without puncture, a lotion made up of an ounce of the solution of the subacetate of lead and three ounces and a half of both spirits of wine and camphor, which was to be applied on a piece of folded flannel and renewed every three or four hours until the skin over the tumor had become inflamed, the application to be reapplied after the lapse of two or three days.

Spurious Cyst.—Besides the simple serous cyst, many examples of tumors of the breast come under the observation of the surgeon the diagnosis of which is much obscured by the presence of cysts—or, rather, of what Mr. Birkett describes as capsules—containing fluid of divers characters; for the development of a cyst in the majority of tumors is a mere accident due to the effusion of fluid, probably serum, more or less blood-stained, into the connective tissue of the part, the fluid separating the solid growth, and so forming an apparent cyst. Such a cyst, however, is not a new development, like the more solid portion of a tumor, nor is it in any way to be compared with the simple cystic formations which are found in the neck or other portions of the body. The existence of the false cysts, therefore, such as I have briefly sketched, in any of the breast tumors, whether adenoid or malignant, is to be regarded as a mere accident, and ought to have no weight in determining either the innocency or the malignancy of the growth under examination; they are the product of a mechanical cause, may occur in either form, and are not special growths or of any intrinsic importance. The diagnosis of the tumor containing such cysts rests, consequently, on other points, and more particularly on such as have been already indicated. As a rule, these so-called cysts are found in the less firm and solid forms of tumor, in such as contain less cellular or connective tissue, and in the more rapidly developed rather than in the slowly formed. We thus find in *one* form of cystic adenoma a more or less solid tumor, the growth being more lobulated and loosely connected where the false cysts or capsules exist. In a *second* class of cases loose pedunculated growths will be seen lying within these capsules, with their floating extremities bathed with the so-called cyst contents (Fig. 446), the different forms assumed by these tumors depending upon the amount of connective tissue which binds together the several lobes and lobules, and the dimensions of the interspaces which go to form the false cysts. In a *third* class, however, the *true cystic adenocele* of the breast, the adenoid solid elements are developed within cysts composed of dilated ducts. But in all, whether within false cysts or in dilated ducts, the elementary structure of the growths is either dense and compact or loose and pedunculated; in all they simulate the structure of normal gland tissue. In some the cæcal terminations of the ducts are the most prominent, and in others the ducts and sinuses, while in a few true milk or cream secretion exists, precisely similar to that secreted by the breast. In all probability, all adenomata are developed in cysts as intracystic growths. Dr. Goodhart has supported this view in an able paper (*Edin. Med. Journ.*, 1872).

FIG. 446.



Cystic Tumor in Breast, with Pedunculated Adenomatous Growth of One Year's Existence. (Removed by T. Bryant from S. W——, æt. 43, in 1876. Three years later patient was quite well.)

DIAGNOSIS OF TRUE CYSTIC ADENOCELE.—This true cystic adenocele, however, is of an innocent nature and pathologically allied to the genuine adenocele. It is the tumor originally described by Sir B. Brodie as "arising by a dilatation of portions of some of the lactiferous tubes," and by Mr. Birkett as duct cysts, distinctly referable to the dilatation of a duct or to a connection with one, and containing growths which appear to spring from their walls; and these two forms of cystic adenocele are strictly analogous in their nature. In both the pedunculated or floating bodies possess a structure allied to the breast gland, and are composed of more or less distinct cæcal terminations of newly-developed ducts, with variable quantities of true connective tissue. This affection is more common in middle than in young life. Out of 12 cases, 6 occurred in women under thirty, 17 in women over forty, while 1 was as old as seventy-one (*Path. Trans.*, vol. xvii. p. 283).

DIAGNOSIS OF CYSTIC ADENOMA.—How, then, is such a tumor to be made out? and what are the special symptoms which characterize it from the other forms of mammary tumor?

First of all, being an innocent tumor, it will be found to affect the patient in a purely

local manner, as do all other adenoid tumors. It is a local disease which at no period of its growth and in no way will affect the patient otherwise than through local causes. It is never associated with secondary glandular enlargements or with deposits in other tissues, as the cancerous tumor, and it can, therefore, be by local symptoms only that a correct diagnosis is to be made.

The tumor, being a *genuine cystic disease*, is always made up of cysts filled with intra cystic growths in different degrees, and *it is also a disease of the gland itself*, the cysts having a distinct relation with the gland ducts. The cysts, having, therefore, in the majority of cases, if not in all, some communication through the nipple with the external surface, can be partially emptied of their contents by pressure through the nipple of the affected organ. As a result, this discharge from the nipple must always materially tend to confirm the impressions which may have been formed by the careful observation of the case, and by the presence of those conditions to which attention has just been drawn.

SUMMARY.—Consequently, *a cystic tumor of the mammary gland* in a healthy woman, unattended by any other than local symptoms and associated with the discharge of a clear or colored viscid secretion from the nipple, which can be induced or materially increased by pressure, may with considerable confidence be set down as the *true cystic adenocele* of the breast. The false adenoceles or other tumors, which have but little if any connection with the true gland tissue, are new growths partaking of the nature of the breast gland, according to the universal pathological law that all new growths partake of the nature and peculiarities of the structure in which they are developed. In Fig. 441 the external appearances of one of these cystic adenoceles are well seen.

GALACTOCELE.

This is a milk tumor found in the breast during lactation, the result of some retention of milk in an obstructed or ruptured duct, the secretion being either fluid milk-like or more solid and creamy, owing to the absorption of the more fluid elements. Preps. 2290[50], 2290[80], and 2299[40], Guy's Museum, illustrate these points. It usually occurs somewhat suddenly during suckling, and is indicated by a painless fluctuating swelling, unaccompanied by any constitutional disturbance. These cysts at times attain a large size. Scarpa has recorded a case in which two pints of milk were removed from the tumor. It should be treated by an incision into the cyst, leaving the walls of the cavity to granulate.

FIG. 447.

Cystic Carcinoma of Breast of Nine Months' Growth. (Taken from S. P——, æt. 56. Skin over breast involved, nipple drawn in, axillary glands enlarged. Three months after operation there was a large axillary growth and œdema of arm. Mr. Birkett's case. Drawing 40[8]2.)

CYSTIC CANCER.

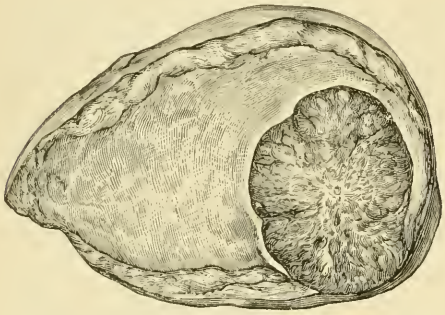
The pathology of cystic cancer is identical with that of cystic adenoma, while the cysts in the one instance contain the more or less solid characteristic lobules of the adenoid growth, and in the other are filled with the less developed and more irregular, but equally characteristic, material which goes to build up the cancerous tumor (Fig. 447). The diagnosis of these cancers rests, therefore, upon such points as have been already described under a former heading.

SARCOMATOUS TUMORS OF THE BREAST.

Sarcomatous tumors of the breast are met with in women of middle age, and they are generally more succulent and less solid than the adenomata and more rapid in their growth, while they have also a greater tendency to return after removal. They are more closely connected with the breast than the adenomata, and are always encapsuled (Fig. 448); they do not infiltrate the breast like the cancers. They run their course, moreover, more rapidly than the former, and have a tendency to break down and give rise to a bleeding mass of tissue which may be mistaken for a cancer. They are also local, and are rarely associated with any secondary glandular enlargement. They should

be dealt with as adenomata and removed, and the breast, as a rule, should be removed with them. I have the records of many interesting examples of this form of tumor, and in the *Path. Trans.* for 1868, vol. xix., I recorded the case of a woman æt. 35 from whom I removed a tumor weighing nearly five pounds. The patient from whom Fig. 448 was taken was thirty-three years of age, and in her no return took place after operation—a result which is not constant, since in a large number of these cases the disease returns locally and acts in that point as badly as any cancer. I have a patient now under care from whose breast I have removed five tumors at different intervals. When a return takes place, the tumor should be excised at once if the measure be practicable.

Fig. 448.



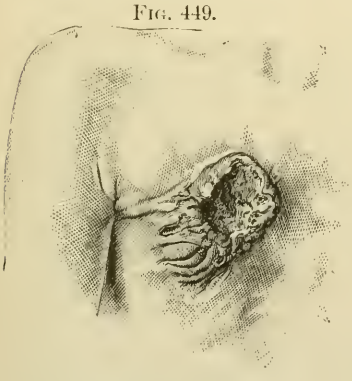
Sarcomatous Tumor of Nine Months' Growth. (Removed from M. T——, æt. 33, by T. Bryant in 1877. Good recovery.)

Hydatid cysts are found in the breasts, but are not common. Only one example has fallen into my hands, although I have seen five others in the practice of my colleagues. My own patient was a woman æt. 30 who for five years had had a *painless globular swelling* in her left breast; and when I saw her, it was as large as a cocoanut. I tapped the cyst and evacuated sixteen ounces of a clear non-albuminous fluid, and, as it was evidently the fluid of a hydatid, I made a free incision into the tumor and turned out a large acephalocyst. The patient made a good recovery.

Nævus, involving the whole mammary gland, may be met with. I have had under my care a splendid example in a girl six years old in which the whole organ was like a sponge and as large as half an orange.

Open, Ulcerating, and Discharging Tumor of the Breast.—In the growth of any tumor situated in the mammary gland or its neighborhood there must be a period when the integuments will become so involved as to ulcerate or give way, and under these circumstances a discharging surface or cavity will present itself varying in its aspect according to the innocency or malignancy of the growth with which it is associated. If the tumor is *cancerous*, the open surface or discharging orifice will suggest its nature, and the integument itself or the margins of the wound will be infiltrated with cancerous material, the latter presenting the thickened, indurated, and everted margin so characteristic of the cancerous ulcer, and which, when once seen and appreciated, can hardly be mistaken (Fig. 449). But if the tumor be *innocent*, a very different condition will present itself, for a clear understanding of which it is essential to recall one or two points of difference between the innocent and malignant tumors, although attention may previously have been drawn to them in former pages. It is the peculiar nature of the innocent tumor to affect the part in which it is developed simply in a mechanical way; it may separate or displace, but never infiltrates, tissues. On the other hand, it is the peculiar nature of the cancerous or malignant to infiltrate and involve every tissue with which it comes in contact. Applying, therefore, these two opposite features of the innocent and malignant tumors to the class of cases now under consideration, we shall readily understand how two very different local appearances may be produced, and how in the cystic cancerous disease the wound or surface will be characterized by all the peculiarities of the cancerous ulcer, and in the cystic innocent tumor which may have ruptured from over-distension the margin of the wound or discharging cavity will look healthy, free from all appearance of infiltration, and as if mechanically cut or punched out rather than ulcerated. In the *cystic adenoceles*, in which it is not uncommon to find a sprouting and discharging intracystic growth protruding from a wound through the ruptured integument, and presenting a very doubtful, and sometimes cancerous, aspect, the importance of this symptom cannot be overrated; for if found projecting through an orifice of the integu-

Fig. 449.



Open Cancer of Breast with Infiltration of Skin. (Model, Guy's Mus.)

ment which is uninfiltrated and apparently healthy, such as we have already described, the innocent nature of the tumor may with some confidence be declared.

Value of the Retracted Nipple as a Symptom in Tumors of the Breast.

There can be little doubt that as a positive indication of cancerous disease the importance of a retracted nipple has been considerably overrated. The symptom may be common in infiltrating cancer of the breast, but such a disease may exist without it; it may be present, moreover, in simple non-cancerous affections. A retracted nipple may be regarded as an accidental symptom in the development of a tumor, as well as the product of mechanical causes, its presence being determined rather by the manner in which the gland is involved than by the nature of the disease. If any tumor, simple or malignant —any abscess, chronic or acute—attack the centre of the mammary gland, a retracted nipple will in all probability be produced; for a disease so placed necessarily causes separation of the gland ducts, and, as a consequence, their extremities, terminating in the nipple, will be drawn upon, and a retracted nipple must follow. We thus find this symptom of frequent occurrence in the early stage of an infiltrating cancer of the organ, the nipple being always drawn toward the side of the gland which may be involved, while at a later stage, when the infiltration is more complete, the nipple may again project. In a central chronic abscess of the breast the retracted nipple is equally common, and in the true cystic adenocele it may be also present. In the ordinary adenocele, whether cystic or otherwise, it is rarely met with, for the reason that this disease is not of the breast gland itself, but only situated in its neighborhood. In rare cases, however, such an association may coexist, and in one case in which I observed it some blow or injury had preceded the development of the adenoid tumor, and it was open to a doubt whether the retracted nipple had not been brought about by a chronic inflammatory condition. It should always be remembered, moreover, that a contracted nipple may be a natural condition.

Value of a Discharge from the Nipple for Diagnostic Purposes.

When the discharge is slight or of a bloody nature, it does not indicate any special affection, though it is well known that in *cancerous* affections a discharge from the nipple is not unfrequent, the fluid having the appearance of blood-colored serum which is never profuse and rarely amounts to more than a few drops. In the *true cystic adenoceles* this symptom is of considerable value, for in all the cases which have passed under my observation, as well as in the majority of recorded examples, this discharge from the nipple was a prominent symptom, the fluid being generally of a mucoid nature and more or less blood-stained; and, although at times it occurred spontaneously and with relief to the patient, at others it could readily be induced by some slight pressure upon the parts. In the *ordinary adenoceles* this symptom is seldom present. It exists, therefore, as a symptom in the true disease of the breast structure, whether cancerous or adenoid, and, while slight and uncertain in the former, it is more general and copious in the latter; consequently, as a means of diagnosis it is of some value.

Chronic Disease of the Mammary Areola preceding Cancer (Paget's Disease).

Sir J. Paget has pointed out (*St. Bartholomew's Hosp. Rep.*, vol. x., 1874) what my own experience confirms—that cancer of the breast is sometimes preceded by a chronic skin disease of the nipple and areola, the disease in the majority of the fifteen cases in which he had observed it having "the appearance of a florid, intensely red, raw surface, very finely granular, as if nearly the whole thickness of the epidermis were removed, like the surface of very acute diffused eczema or like that of an acute balanitis. From such a surface there was always copious, clear, yellowish, viscid exudation." In some cases the eruption has presented the characters of an ordinary chronic eczema or psoriasis, the eruption spreading beyond the areola in widening circles or with scattered blotches of redness covering nearly the whole breast.

"The eruption has resisted all treatment, both local and general, and has continued even after the affected part of the skin has been involved in the cancerous disease."

Mr. Henry Butlin has shown that these changes are due to an extension of the disease from the surface of the nipple to the smaller ducts and acini of the gland, these parts

being found, on microscopical examination, filled with proliferating epithelium, which at times escapes from the ducts by rupture or growth into the surrounding tissues, thereby producing the full formation of carcinoma (*Med.-Chir. Trans.*, January, 1877), the mechanical retention of the epithelial element within the gland and ducts evidently playing an important part in the progress of this disease. Whether the disease be a true eczema or a specific dermatitis—a question which has to be determined—the conclusion is clear that the local disease is not to be disregarded. When much epidermis collects upon the nipples, "Busch's practice in cases of epithelioma ought to be followed, and such should be removed by the application of a lotion of soda from three to six grains to an ounce;" and if any suspicious hardness of the base of the sore exists, it should be removed.

Importance of Enlargement of the Absorbent Glands as a Diagnostic Symptom.

When some enlargement of the axillary or clavicular glands exists with a chronic tumor of the breast, the malignant nature of the disease is rendered probable; for the simple adenomata are generally unattended by such a complication, and with the cystic affections it is also rare. Many months, however, may elapse in cases of cancer of the breast before the appearance of this symptom, because enlargement of the absorbent glands and infiltration of the skin have some connection.

In cancerous affections the enlargement of the glands is indolent and very painless. In the inflammatory affections of the organ glandular enlargement and tenderness are commonly present.

Value of the Tubercular and General Infiltration of the Integument over the Breast.

When the integument of a breast is sparsely or thickly studded with shot or pea-like tubercular infiltrations, or is so infiltrated with new material as to present a brawn-like feel and aspect, there can be no question as to the cancerous nature of the disease, since such a symptom is never present in any inflammatory or simple disease of the mammary gland. The infiltration may be slight, from the mere shot- or pea-like affection of the skin, to its more brawny infiltration, but in all stages it is equally characteristic and speaks in positive language of the cancerous nature of the mammary growth, one tubercle telling as plain a tale as if many tubercles existed.

Cachexia.

I have no belief in the existence of a special cancerous cachexia. A cachexia may be present in cancer as in any exhausting or wasting disease, but that of cancer differs in no single point from that of any other affection. When a cachexia exists, it indicates the presence of some affection which is undermining the patient's strength, which may be cancer, but it may be any other form of disease.

Excision of the Breast.

There is no great danger attending excision of the breast beyond that which accompanies any operation, even the smallest. It is true that patients occasionally sink after the operation, from pyæmia, erysipelas, or visceral diseases, but these contingencies attend any operation or wound. From my notes of 133 cases of cancer in which excision was carried out I find that 9 died, or about 6.7 per cent., while in 4 only, or 3 per cent., could the death be ascribed to the operation. One died from pyæmia, on the thirty-fifth day; 1 from erysipelas, contracted several months after the operation, when the wound had healed; 2 from acute bronchitis, three weeks and a month respectively after the excision; 1 from profuse diarrhœa, on the eighth day, probably pyæmic; 1 from hæmoptysis, in the third week; 2 from exhaustion after a return of the growth, in three and six months; and 1 from actual sinking after the operation, on the third day. The 3 cases which died from pyæmia and diarrhœa which was also probably pyæmic, and the 1 which sank on the third day may, perhaps with justice, be directly assigned to the operation, but the fatal termination in the remaining 5 examples had no reference whatever to the excision. In the operations for innocent tumors of the breast no fatal instance occurred.

In operating for cancer it is unquestionably the wisest course to excise the whole gland. It is well not to be over-anxious about preserving too much integument; and if any doubt exists as to its perfect healthiness, the suspected portion had better be excised. When enlarged glands exist, they should be taken away; and in any doubtful case the axilla should be explored. It is always important, when dissecting out the tumor, to keep clear of all diseased tissues, and in fat subjects to leave a fair covering between the incision and the tumor itself, as there is good reason to believe that an early return of the affection is too often to be explained by want of attention to these points. In several instances I have found small cancerous nodules in the fascia over the pectoral muscle which if left would have been the centre of new growths. In the operation for *adenocele* it is quite exceptional for the removal of the breast to be necessary. In the majority of instances such a practice would be clearly unjustifiable. As a rule, the tumor is readily removed by making a clean section through its cyst wall and enucleating the growth; the breast is rarely injured, even by the operation. In exceptional examples of this affection, however—that is, where a large tumor is closely connected with the mammary gland—as well as in the genuine or true cystic adenocele, it is absolutely necessary that the breast gland should be excised. In the removal of a small tumor not involving the breast the best practice is to make the incision in a line radiating from the nipple and to manipulate the parts as little as possible, the surest plan being to cut well into the tumor after having raised and made it prominent by grasping its base with the thumb and finger of the opposite hand.

Operation.—In the removal of a breast the patient should be placed on her back with the shoulder of the affected side raised by a pillow and the arm drawn out at a right angle to the body (Fig. 450).

The incision should be elliptical and made in a line parallel with the fibres of the pectoral muscle; and when the skin is diseased, it should be removed. The inner or sternal incision should first be made, and bleeding is to be controlled by the pressure of the fingers of an assistant. The second or pectoral incision may then follow, and should be made down to the free border of the pectoral muscle, the definite form of which is the best and surest guide to the base of the gland. The whole tumor by these means is thus readily excised, a few touches of the scalpel dissecting it off the pectoral muscle. The axillary angle of the tumor should be divided last, as it usually contains the chief vessels that supply the gland. The incision can be extended upward into the axilla, to explore or remove the glands. When this is done, an incision at right angles to the wound backward is good for drainage purposes. All bleeding vessels should be twisted, the surface of the wound cleaned with iodine water, its edges well adjusted, a drainage tube introduced at the most dependent part, and steady pressure applied by means of pads of lint, gauze, or cotton-wool. *Adenoid* or innocent tumors should be excised only if they are steadily increasing and are sources of trouble. *Cancerous* tumors should be removed as soon as the diagnosis of their existence is clear; for accumulated evidence tends to show that the earlier a cancer is removed, the better are the prospects of a complete or lengthened immunity from the disease, and that, whether the disease returns soon or late, the best chance is thus afforded to the patient.

Fig. 450.

Excision of the Breast, with Incision Backward for Drainage.

CHAPTER XXVII.

ON OVARIAN DISEASE AND OVARIOTOMY.

The ovaries are glands and are developed as other glands, being composed of like elements. In them, during infancy and childhood, although cell growth, and even cell shedding, may go on, such processes take place silently, unattended by any external manifestations of their action. At puberty, however, when the ovum has matured and impregnation becomes possible, external signs of these changes appear with menstruation, and with these changes functional disturbances of the ovaries and parts connected with them occur and may require the attention of the physician. The surgeon's aid is called for only when organic ovarian disease exists, and the nature of this aid varies with the nature of the case.

Ovarian Disease.—Ovarian disease is a somewhat common affection, and, although mostly met with during the active period of ovarian life, it occurs in childhood and mature age. Two specimens now in the College of Surgeons were taken from twin children five and eight weeks respectively by Dr. Leared, and a rare preparation at Prague shows a cyst in the ovary of a child a year old. Roemer of Berlin in 1884 records a case in which he successfully removed a dermoid ovarian tumor from an infant twenty months old (*Brit. Med. Journ.*, April 12, 1884). Kidd of Dublin has operated on a child aged three. Spencer Wells has recorded a successful case of ovariotomy in a child aged eight. Dr. Barker of Philadelphia had another in one aged six years and eight months. I have recorded two cases in which girls aged respectively fifteen and sixteen sank after tapping from suppuration of the cyst; and in 1869 I published in the *Guy's Hospital Reports* a case in which I successfully removed a polycystic ovarian tumor from a child aged fourteen in whom no signs of puberty existed. But these instances are exceptional, and ovarian disease is essentially an affection of mature adult life. In Spencer Wells's thousand cases the age averaged thirty-nine.

Ovarian tumors may be clinically divided into four classes: *Monocystic*, or unilocular tumors; *polycystic*, or multilocular tumors; *dermoid* cysts; *fibrous* and *cancerous tumors*. The relative frequency of these different forms of tumors is well seen in the following conclusions, which were drawn up after a careful examination of the records of 88 fatal cases of ovarian disease extracted for me by the late Dr. Phillips from the Guy's records, and copied from my work *On Ovariotomy* published in 1867.

Conclusions *drawn from an analysis of 88 fatal cases of ovarian disease:*

1. That 9 per cent. of the ovarian tumors are apparently monocystic, 9 per cent. dermoid, 18 per cent. cancerous, and the remaining 64 per cent. polycystic or more or less solid.

2. That 53 per cent. of the cases are on the left side, 20 per cent. on the right, and 17 per cent. double.

3. That simple cystic disease of the ovary is rarely double, and that when double ovarian disease exists the majority of the cases are cancerous, colloid, or of the solid kind.

4. That about 70 per cent. of the cases are in married women, and that the disease is most frequent between the age of twenty and forty, or during the vigor of sexual life.

5. That the disease runs its course in at least 75 per cent. of all cases within two years, 30 per cent. dying from exhaustion, 20 per cent. from peritonitis, 17 per cent. from suppuration of the cyst chiefly following tapping, 9 per cent. from the last two causes combined, 10 per cent. from peritonitis caused by rupture of the cyst, 10 per cent. from the cyst ulcerating into some viscus such as the intestine or bladder. Hemorrhage into the abdomen and strangulation of the bowels by the pedicle caused death in one case.

6. That in the *monocystic* tumors there is a greater disposition for the cyst to ulcerate into the bowels than in other cases, and to suppurate after tapping.

7. That in 56 per cent. of the cases of cancerous disease both organs are involved.

8. That in the dermoid tumors there is a greater disposition for the cyst to rupture than in all other forms of disease, death being directly due to this cause in 37 per cent.

9. That acute peritonitis and suppuration of the cyst as a direct result of the operation of tapping are by no means unfrequent.

Cases of *spontaneous recovery* occur, but they are so rare that they must not be looked

for. When they occur, they take place by rupture of the cyst; and this rupture is generally the result of accident or violent muscular action. As a rule, however, when a cyst ruptures, death takes place from shock, peritonitis, or blood poisoning (*vide* Conclusion 5). In exceptional cases, when the cyst has discharged itself into the large intestine, the event may be signified by a copious discharge of the cyst's contents by the rectum; but when into the small bowel, no such event may occur, the fluid being reabsorbed. Under both circumstances there is always great danger to life from the entrance into the cyst itself of fecal matter or fetid air.

Diagnosis of an Ovarian Tumor.

When an ovarian tumor has attained a considerable size, has risen well out of the pelvis, and is unassociated with any complications, its diagnosis, as a rule, is not difficult, more particularly if it can be made out to be composed of many cysts—*i. e.*, multilocular. But when the tumor is small or very large, unilocular or very solid, central or of rapid growth, difficulties of diagnosis are met with, and it may be admitted at once that under any of these circumstances there are few surgical cases that demand more care on the part of the surgeon before he gives an opinion, and still more caution before he acts upon it. In some few instances, indeed, a positive diagnosis cannot be made without the help of some exploratory operative proceeding. Under all circumstances, however, "in the diagnosis of a suspected ovarian case, every possibility of its nature should be entertained and a conclusion arrived at by a process of exclusion; each possibility should be separately considered and weighed and the most probable finally accepted."

The possibility of a solid or semi-solid tumor being due to pregnancy and the probability of a cystic tumor being complicated with pregnancy or hydramnion ought always to be before the mind of the surgeon, while the complete cessation of the menses for a few months in connection with the existence of an abdominal tumor ought also to suggest in diagnosis caution and delay when for diagnostic or curative ends operative measures are being considered, since, though catamenial irregularity is common in ovarian disease, total arrest for any time is rare.

The early history of an ovarian case is always obscure, and the statements of patients concerning its early growth must be accepted with caution. In a general way the tumor is discovered by accident, or attention is first drawn to its presence by abdominal enlargement.

Pain is rarely present in the early stage of the disease, and when it exists is usually the result of mechanical causes—that is, it is due to the impaction of a small ovarian tumor in the pelvis or to the pressure of a larger one upon the viscera, vessels, or nerves.

When the tumor presses upon the bladder, incontinence of urine or dysuria will occur; but when it irritates the bowels, diarrhœa will be caused. When it drags upon the omentum or presses upon the stomach, nausea and vomiting may be present; and where it encroaches upon the thorax, dyspnœa. Nerve pains will be produced according to the nerves that are pressed upon, and œdema of the genitals, legs, or abdomen according to the amount of interference to the return of venous blood is commonly caused by the tumor. Œdema of the abdominal walls is said to be typical of cancerous disease of the ovaries, but this is not the case, since I have seen this symptom very frequently in undoubted examples of simple ovarian disease.

Local pain, pyrexia, with a high temperature and abdominal tenderness, associated with a cystic abdominal tumor, generally indicate inflammatory changes within an ovarian cyst.

Dermoid tumors are said to be more commonly, and unilocular cysts least frequently, attended with pain than any other.

In well-marked examples of ovarian disease the face becomes pinched and the peculiar "ovarian expression" manifests itself, but after the removal of the tumor by ovariotomy it is remarkable how soon this expression disappears.

The DIFFERENTIAL DIAGNOSIS of an ovarian tumor will now occupy our attention, and its physical signs will be first considered as made out by percussion and palpation, since it is by these more than any others that the surgeon is generally led to an approximate opinion of the nature of the case. Too much confidence, however, must not be placed on them, since they are of value only when taken in connection with other symptoms.

In all cases of suspected ovarian disease the patient to be examined should be undressed and then placed on her back with her shoulders and knees raised. The surgeon should afterward so expose the abdomen as to be able to have a good look at it and observe

whether the abdominal enlargement is central or lateral, smooth, irregular, or nodular in outline. Should the tumor move upward and downward during the respiratory act, the tumor is probably free and non-adherent. The surgeon should then place his hand flat upon the abdomen, and, having rested it there for a minute or so to test the points just alluded to, should move it steadily over the whole surface of the tumor in all directions, and at the same time, by palpation, ascertain something of the condition of the deeper parts.

By these means much will have been ascertained as to the nature of the case. It will have been made out whether a tumor exists or not; something will have been learnt, too, concerning its size and mobility and whether it is solid, fluid, or the two combined. Possibly by some sudden movement of the contents the question of pregnancy may be raised or settled.

The surgeon should then proceed to percuss the parts, doing this at first superficially and then deeply. He should also examine for fluctuation, asking himself during the whole examination the following questions: Is this abdominal enlargement due to tympanitis, or is it some phantom—that is, muscular—tumor? Is it due to or complicated with pregnancy, or is it uterine or ovarian disease? Can it be a hydatid, pancreatic (*Lancet*, February 11, 1882), or renal cyst, or an enlarged viscus, such as spleen or kidney? Is it a cancerous tumor?

A fluctuating tumor rising from the pelvis in a central position, yielding a dull note on superficial as well as on deep percussion, with epigastric and lumbar resonance, is probably a cystic ovarian growth; and when the tumor fluctuates in all directions, as is proved by the peculiar thrill of the wave elicited on percussion, the growth is probably *unilocular* or monocystic. When the tumor has an irregular or botryoidal outline and fluctuation is confined to parts, it is certainly *compound*, the degrees of solidity in a compound or multilocular tumor varying greatly. If the tumor seem to be a unilocular or monocystic growth, the surgeon must remember that ovarian tumors of this kind are comparatively rare, and that those which appear to be such often contain some intracystic growths. He should also know that purely unilocular cysts are probably broad ligament or parovarian cysts—that is, a cystic degeneration of the tubules of the Wolffian body—although multilocular parovarian tumors have been recorded.

If the tumor be clearly cystic and multilocular, the probabilities are that it is ovarian; and if more solid than cystic, it will probably be dermoid or uterine.

Uterine and ovarian tumors yield a dull note on deep percussion, and as, in these cases, the intestines are pushed upward and toward the loins, these regions are consequently resonant, and no alteration in the position of the patient will alter this fact. In ascites, with the shoulders of the patient raised, the lower portion of the abdomen may likewise yield a dull sound, but with the shoulders depressed and the hips raised resonance will be made out, the bowels naturally floating on the surface of the ascitic liquid. In ascites the central portion of the abdomen is resonant and the sides are dull, whereas in ovarian dropsy it is the reverse. "In ascites the greatest circular measurement is at the level of the umbilicus: in ovarian dropsy it is often some inches lower down" (Wells). When the intestines are matted together from cancerous or old peritoneal disease, difficulties occur, and errors in diagnosis can be avoided only by going carefully into the clinical history of the case and by a pelvic examination. In ovarian disease a friction sound may be detected at times on auscultation or on the application of the hand, while in ascites no such symptom will be present.

Diagnostic Value of a Pelvic Examination in Ovarian Disease.

The diagnosis of an ovarian tumor can hardly ever be said to be complete until a pelvic examination by means of the finger and uterine sound and the combined examination between the abdominal wall and rectum have been made, for which purpose the patient had better be placed on her side.

When the uterus is found to be in front of and distinct from the abdominal tumor and movable without it, the growth is probably ovarian. When the tumor and uterus move together, or if the uterus be drawn up out of the pelvis, difficulties in diagnosis may be experienced. If the tumor be cystic, it may be ovarian with a short pedicle, a broad ligament or parovarian cyst, or a cystic disease of the uterus. When it is solid, it may still be ovarian, dermoid, fibrous, or cancerous, or it may be a fibrous tumor of the uterus.

A fixed pelvic tumor is probably neither ovarian nor uterine; but if either, it is cancerous.

In an ovarian tumor the uterine sound will rarely go beyond two inches, unless complicated with pregnancy or some uterine disease. In cystic disease of the uterus it may enter for six or more.

The uterine sound should not be used too hastily for diagnostic purposes, because when pregnancy and ovarian disease are combined evil may follow its use, although it ought always to be employed before operative measures are resorted to.

When ascites is present, a pelvic examination will generally detect a vaginal rectocele—that is, a bulging into the vagina of the posterior wall of the vaginal passage from the pressure of the ascitic fluid into Douglas's pouch; and this bulging is not met with in uncomplicated ovarian disease, though it may occur when ovarian disease and ascites coexist. I have found this point of great diagnostic value for many years, and was pleased to read that Dr. Peaslee had mentioned it as one of value.

"Solid uterine tumors," writes Tait, "besides the absence of fluctuation, have in addition two vascular signs which I have never met with in ovarian tumors—viz., an aortic impulse which may be seen and felt, and an enlargement of the uterine arteries to be felt in the vagina."

In pregnancy there is also to be seen the peculiar purple livid condition of vagina which does not exist in other pelvic tumors, the changed appearance of the nipple, enlargement of the breasts, etc.

I have often found the value of rectal digital examination for diagnostic purposes to be great, and particularly in young or old virgins, but I cannot speak from personal experience of the value of the introduction of the hand. Professor Simon of Heidelberg, however, speaks highly of it.

Value of Tapping for Diagnostic Purposes.

When there is any doubt as to the true nature of a cystic abdominal tumor, a preliminary tapping ought to be performed and the physical nature of the fluid examined, although in our present state of knowledge an ovarian fluid is not to be recognized by any definite physical or chemical characters. Drs. Washington Atlee and Peaslee, however, inform us that the fluid of an ovarian cyst may be distinguished from all fluids by the presence of a peculiar cell—which they call the ovarian granule cell—which is about the size of a pus cell, round and full of granules, and Mr. Thornton has recently confirmed these observations (*Path. Soc.*, March 16, 1875), adding, moreover, that large pear-shaped, round, or oval cells containing a granular material with one or several large clear nuclei, with nucleoli and a number of transparent globules or vacuoles, are characteristic of malignant tumors.

When, from what appears to be a monocyst, the fluid drawn is clear, slightly opalescent, and limpid, of a low specific gravity, about 1005, and non-coagulable by heat or nitric acid, or if coagulable by heat the coagulum is redissolved upon the addition of boiling acetic acid, there is a strong reason to suspect that the tumor is a broad ligament or parovarian cyst, and under such circumstances there is good reason to hope that a cure may follow the operation of paracentesis, or, if not a cure, the lapse of a long interval of time before the repetition of the operation is called for. This fact was pointed out by the late Dr. F. Bird (*Med. Times*, July 19, 1851).

When the fluid drawn off is clearly albuminous, tenacious, dark, or light colored, when it is even watery and like that contained in the cysts last described, and is found microscopically to contain the compound cells or epithelial elements already referred to, the tumor is probably ovarian and ought to be removed.

When the fluid drawn off is highly albuminous and coagulates spontaneously, the suspicion of the tumor being a fibro-cystic uterine one ought to be raised, though there is little doubt that the true diagnosis of a fibro-cystic uterine tumor from a polycystic ovarian can only be made out in the majority of cases by an exploratory incision, when the absence of the pearly appearance of the ovarian and the presence of the pinkish, vascular, and fleshy aspect of the fibro-cystic are enough to excite the surgeon's suspicion of the uterine nature of the growth.

When pregnancy and well-developed ovarian disease coexist, tapping ought to be performed, though in cases where the operation is inadmissible, from the nature of the tumor, ovariotomy is a justifiable proceeding, Spencer Wells and other surgeons having performed the operation in many cases during pregnancy, and with success; it should, however, be undertaken before the fourth month. When the tumor is small, it should be left alone.

The Treatment of Ovarian Disease.

In the treatment of ovarian disease medicine is of little value and has no direct influence in arresting its progress. It does good only by improving the general condition of the patient. The operation of tapping in unilocular cysts is, however, often of great value, and at times essential. Injection of the cyst is applicable only to a small class of cases. Ovariotomy, in a general way, is the only radical cure.

John Hunter clearly realized the truth of this in 1787, when he said, "In the early stage of ovarian dropsy I would almost advise that they should be *removed entirely* if the complaint can clearly be ascertained, as they otherwise will certainly kill the patient." He adds, however, that "*electricity* has been serviceable lately in diminishing the progress of the formation of the fluid in a patient I am acquainted with. How far it will be of further service I cannot say" (MS. lectures).

At the present day the operation of ovariotomy is an accepted one by the profession, and is as recognized and justifiable as any other grave operation. Surgeons and physicians differ only as to the class of cases in which it is applicable and the period at which it should be performed.

British surgeons may probably claim the credit of having established this operation in spite of early difficulties and blind opposition, and the names of Lizars of Edinburgh, MacDowell of Kentucky, Jeaffreson of Framlingham, Walne, Fred. Bird, Lane, Morgan, Aston Key, Cooper, and Cæsar Hawkins of London, must ever be remembered as amongst its earliest practical promoters. Charles Clay of Manchester, however, the first great ovariotomist in this country, Brown, and particularly Spencer Wells, of London, Keith of Edinburgh, Koeberle of Strasburg, Sköldberg of Stockholm, and Atlee of America, with Hutchinson, and possibly the present writer, have by their successes fairly overcome all prejudices and rendered the operation an established and accepted one. Without going into the details of statistics, which are now no more needed in this than in other large operations, it may be confidently asserted that the operation is not placed in too favorable a light when it is said to be successful in three out of every four cases, good, bad, and indifferent, and in at least nine out of ten selected cases. Sir Spencer Wells informs us, as the result of his unrivalled experience, that out of his 1000 cases, 232, or 23.2 per cent., died, whilst T. Keith lost only 41 out of 381 cases, or 10.7 per cent. Lawson Tait tells me that with the year ending 1883 he had 209 cases of removal of one or both ovaries for cystic disease with but 7 deaths, or a mortality of 3.3 per cent., and that of 36 cases of operation for cystic disease of the Fallopian tubes he had no death. "If ovarian tumors," he adds, "are operated upon as soon as they are discovered, and never tapped, there would be a mortality hardly perceptible."

"I have become," writes Spencer Wells, "more and more disposed to advise the removal of an ovarian tumor as soon as its nature and connections can be clearly ascertained and it is beginning in any way, physically or mentally, to do harm, since the risk of the operation under such circumstances is certainly less, and the possible evils of delay are eluded."

When delay must ensue, one of the minor methods of palliative surgical treatment may be required, such as tapping, tapping and draining, incision, or tapping and iodine injection.

Tapping.—This operation may be required for diagnostic purposes, and for relief when other operative measures are necessarily or wisely postponed or have been rejected. It should always be practised once in monocystic tumors, since in such it may possibly prove curative and probably postpone operative interference for years. It is not to be recommended in compound or semi-solid tumors. Spencer Wells, however, maintains that one or more tappings do not increase *considerably* the mortality of ovariotomy.

Injection of Iodine.—In the simple or *monocystic* ovarian tumors, when the diagnosis is clear, the treatment by injection of iodine may be employed. M. Boinet says that out of 45 patients suffering from this disease, 31 were cured, 5 had relapses, and 9 died. Sir J. Simpson performed it in about 20 cases with good success, only 1 case dying, while Dr. Tyler Smith found that out of 10 cases in which this practice was followed, 2 only were satisfactory and 2 died. Dr. West in 8 cases had 1 cured.

The method at the best is uncertain. Spencer Wells does not advocate it. In the majority of cases it does no good, and may even be followed by a fatal result. It is applicable only to simple cases of ovarian or extra-ovarian cysts.

Incision.—This method is applicable only when the operation of ovariotomy is found impossible from the adhesions or attachments of the tumor. Under these circumstances,

in certain cases, it is of immense value. In 1877, I had this truth illustrated in the person of Amelia B——, æt. 20, who had recognized the presence of an abdominal tumor some months before she became pregnant. After the confinement, which was normal and the child alive, the tumor grew rapidly; and when she came under my care her abdomen measured fifty-six inches in circumference.

I operated upon her, but, having found a monocyst universally adherent, I emptied it and evacuated many quarts of a viscid fluid, washed the cyst well out with iodine water, dried its cavity, and then drained it. For about a week there was some draining of serous fluid, but there were no constitutional symptoms. The cyst was irrigated daily with iodine water. By the eleventh day the cavity had considerably shrunk. On the twenty-fifth it would not hold an ounce of fluid. By two months it had quite healed, and the woman returned home.

I have performed a like operation to the above in three or four other cases where suppuration existed, and with success.

When Operation is Required.

Cases of the polycystic or dermoid kinds should, as a rule, be operated upon as soon as they become sources of local or constitutional distress. "Justice," says Wells, "in these cases demands a most positive recommendation of excision, with a warning against delay." "Every ovarian tumor," writes Schröder of Berlin, "ought to be removed as soon as it has been discovered."

It should not be entertained, however, when other organic disease is present or when the local disease is clearly cancerous. The operation is a formidable one; but if the general condition of the patient be good, the prognosis is favorable even when the tumor is large and looking unfavorable for removal.

The **size** of a tumor has not appeared to have had much influence on the result, although when it is solid and requires a large incision for its removal the dangers are increased, small incisions, without doubt, being better than large.

Adhesions to the abdominal walls, parietes, or omentum have but little influence upon the mortality, but pelvic adhesions are always grave and visceral dangerous.

The **length of the pedicle,** when the clamp was used, was a matter of importance, short pedicles adding to the danger of the case by necessitating dragging of the uterus upward. At the present time, when clamps are abandoned and the intraperitoneal method of ligating the pedicle and dropping it in is the common custom, the length or the shortness of the pedicle is of small importance.

The **breadth** or **thickness of the pedicle** is, however, a question of consideration, since a broad pedicle of necessity requires many ligatures, and a thick one is difficult to ligate with safety.

The Operation of Ovariotomy.

The preliminary treatment of a patient about to undergo the operation of ovariotomy need not differ in any way from that which experience has taught us to be called for previous to any other capital operation. We should do our best to raise the standard of health by all those general hygienic and other influences which are well known to act beneficially, such as good air, simple nutritious diet, a fair amount of stimulants, and the administration of some tonic. Let the patient take exercise, when she can without pain, and be careful that it is kept within the limits of fatigue, that it be taken on level ground, and that no shaking or straining be on any account allowed; and when she is at rest, the half-reclining position ought to be usually assumed. For a day or two before the operation, however, exercise, even when possible, is not to be advised, as quiet and repose are then of some essential service. The urine should be carefully examined; and if scanty and concentrated, the operation must be delayed. Lithia water and alkalies are always useful in exciting a free secretion of urine and in making it clearer.

As a tonic medicine iron appears to be of real and important value: it has apparently an influence for good which other tonics do not possess. It is no more useful, however, before the operation of ovariotomy than before any other capital operation, though it is as good, and I have often thought that in hospital practice wounds are less prone to inflame and erysipelatous affections are less common under the influence of this medicine than when no such preliminary treatment has been adopted. In peritoneal operations this point is of primary importance, and, as a consequence, the adoption of this practice

should be recommended. The form of iron I prefer is the tincture of the perchloride, twenty drops combined with a like quantity of spirits of chloroform or of syrup of lemons or tolu and a drachm of glycerine in water forming a pleasant draught.

The bowels of the patient should be gently opened two days previously by such a mild aperient as castor oil or a draught composed of ten grains of rhubarb and twenty of sulphate of potash in some aromatic water, and on the morning of operation the large intestine should be washed out with a warm-water enema; but nothing like powerful purgation should be allowed under any consideration. Care should also be observed that the catamenial period has passed for at least a week previous to the operation, as all ovarian excitement is necessarily injurious at such a time and should be avoided. I have known cases of ovariotomy, however, undertaken without any consideration of this point, and believe that under such circumstances an untoward result is to be expected.

In hospital practice the patient should as much as possible be isolated from all others and kept in a private room in which good ventilation exists; a special nurse should also be secured, who is not only entirely trustworthy, but understands how to use a female catheter. Country patients should not be brought into town unless an urgent necessity exists, as there is little doubt that the atmosphere of a large city is not so conducive to the rapid reparation of a wound as fresh country air. In abdominal surgery this influence for good is of great value, and should not be thrown away unless from necessity.

The surgeon who is to operate, as well as his assistant, should not allow himself, for a few days before the operation, to visit the post-mortem or dissecting room, nor should he handle any morbid preparations. Erysipelatous affections and all contagious diseases should also be shunned as much as possible; indeed, the same rules which are observed by the careful obstetric practitioner are necessary to the surgeon who undertakes the operation of ovariotomy, since the same subtle poisons which are recognized by all to be hurtful to the puerperal woman act with equal force upon the subject of ovarian as of other diseases when submitted to operation, and, as a consequence, should be studiously avoided. It follows, therefore, as regards the lookers-on at an operation and all who may come in contact with the patient, that none who may bring infections or contagious disease should on any account be admitted. The physician who is attending a case of puerperal fever is looked upon as a possible poisoner as far as concerns the puerperal woman. The medical attendant of a scarlet-fever case, of erysipelas, or other contagious disease should be regarded in the same light in the presence of an ovariotomy operation, and should be excluded. Hence, in hospital practice, great care is needed to exclude all such possible means of injury as have been briefly enumerated.

I need hardly allude to the necessity of all bed and bedding, blankets, sheets, and hangings being perfectly fresh; all sponges being *new*, soft, well cleansed, scalded, and free from soap and grit; and every instrument to be employed being scrupulously clean. The hands of the operator should likewise be thoroughly cleansed from soap just previous to the operation and be well warmed, for manipulation with a cold hand cannot but prove injurious to an exposed peritoneum.

Temperature of the Room in which the Operation is Performed.—There is still some difference of opinion on this point among operating surgeons, Dr. Clay of Manchester, Peaslee of America, and others, advising that the operating room be heated to 75° or 80° F. and a good supply of moisture engendered by the diffusion of steam, while Wells and others make no such rule. Speaking from my own experience, I have no faith in the adoption of such a practice. I would have the room heated to a comfortable temperature, 65° being amply sufficient, since a greater heat acts as a powerful depressant upon the patient and can do no good. A warm room with good ventilation is what I always seek in preference to a hot one with closeness. A cold damp room is to be condemned under all circumstances.

Position of the Patient.—The horizontal position is that which patients suffering from ovarian disease can rarely assume; and when the tumor is so large as to require ovariotomy, this position becomes almost impossible. As a consequence, the half-reclining position is the most comfortable for the patient and convenient for the operating surgeon. It is the posture I have invariably adopted in the cases which have fallen into my hands, and I know of no good reason why it should be changed.

The semi-recumbent position affords all the advantages which have been claimed for other postures without their evils; in it the tumor can readily be removed from the abdominal cavity, and with care its fluid contents can without difficulty be prevented from passing into the peritoneal cavity. There is also abundant room for every manipulative act that can be required.

Administration of Anæsthetics in the Operation.—Among the many incidental advantages which the introduction of anæsthetics has afforded beyond that of relieving pain, few are greater than that of obviating hurry—a point of critical importance in ovariotomy; and there can be little doubt that the success of the operation has thus been greatly influenced by their use.

It is true that operations for the removal of an ovarian tumor were undertaken before the introduction of any anæsthetic, but we all know how fatal were their results and how exceptional was recovery. Those who had an opportunity of witnessing the performance of an operation under such unfavorable circumstances can hardly wonder that so many patients succumbed to the practice, although they might be surprised that any were found to convalesce. To see a patient writhing under the agonies of an abdominal section was enough to make the hardest heart turn with horror, and to witness the surgeon's hands within the abdomen of a struggling woman in his endeavor to remove an adherent growth was almost sufficient to make any professional spectator decide that such an operation was really unjustifiable.

How, in such a case, was it possible for a surgeon to be quiet in all his movements, gentle in his manipulations, and thoughtful over the difficulties which of necessity present themselves in an ovarian operation, when the cries of the patient's agony stimulated him to expedition and her struggles forbade gentleness? All surgeons who have operated upon these cases will agree that success, even under favorable circumstances, is only to be acquired by attention to these points; that hurry in any operation is always bad and unjustifiable, while in ovariotomy it is destructive; that force is never to be employed in any case where art will answer; that in ovariotomy all blind force and dragging is to be strongly condemned; and that in a proceeding in which steadiness in operating, gentleness in manipulating, and thoughtful attention to every detail are absolutely essential to success the safety of the patient must depend upon her quietness and passiveness under the surgeon's treatment.

Under these circumstances the value of some anæsthetic cannot be too highly praised, for by it the patient is not only rendered insensible to pain, but her perfect quiescence is guaranteed and her passiveness under the hands of the operating surgeon completely ensured.

The vomiting that occasionally follows is the only argument against the inhalation of an anæsthetic, but this is an evil which must be endured for the sake of the positive good it affords. By the use of the nitrous-oxide gas followed up by ether, or of the chloroform mixture, of alcohol one part, chloroform two, and ether three parts, as recommended by the chloroform committee of the Royal Med. and Chir. Society, vomiting is certainly less common than after the use of chloroform alone, and as a general anæsthetic it should be employed. When chloroform or bichloride of methylene is used, it should be given by "Junker's" spray apparatus.

Extent of the Incision into the Abdominal Parietes.—The temperature of the room, the position of the patient, and the propriety of the administration of anæsthetics having received our attention, the operation itself next claims consideration; and the first thought naturally is as to the extent of abdominal incision required, as there is still a want of unanimity in the practice of different surgeons upon this point.

Care to have the Bladder Empty.—Before commencing, the careful surgeon, standing on the right hand of the patient, will see that the bladder has been emptied by means of a catheter, the linen of the patient well drawn up out of harm's way and freed from the chance of becoming soiled by the use of waterproofing, the limbs of the patient well protected and kept warm by a pair of drawers and covered by a clean sheet, either with or without a blanket, the abdomen covered by a long piece of waterproofing with an opening in the middle eight inches long by six wide, with its inner surface rendered adhesive by a coating of plaster. He should also see that all his assistants are carefully arranged and special duties assigned to each, and that every instrument that may be required is clean and nigh at hand. He should proceed to make his incision as soon as the patient has been brought completely under the influence of an anæsthetic, though previously he should determine as to its length. From Mr. Walne's, Sir J. Simpson's, and Dr. Clay's practice it might be argued that the long incision should always be adopted, since their success has been great and in their practice the long incision has been invariably employed. From the practice of Dr. Keith, Sir Spencer Wells, Lawson Tait, and others, the short incision would appear to be the better, for their success has at least been as good as that of Dr. Clay and others, and as a rule the short incision has been the one selected. I regard the truth as between the two extremes. When the tumor can

be removed with facility by means of a short incision, a long one is clearly not required; and when the tumor is monocystic, or nearly so, and free from abdominal adhesions, it may be so removed. But when the tumor is large and semi-solid, or when adhesions exist which cannot be readily broken down by the employment of gentle traction upon the growth, it is the best practice, doubtless, to make a long incision, as by so doing the removal of the growth is much facilitated and the causes of its abdominal retention and the connection of the adhesions are satisfactorily ascertained, and, as a consequence, can be dealt with with greater safety.

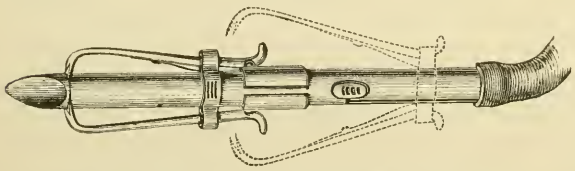
My own practice has hitherto been influenced by such a conviction, and I have in all cases commenced the operation by making a short abdominal incision, and in many have been enabled to remove the tumor without further trouble. But in certain examples in which difficulties appeared, and in which it was clear that adhesions existed for the breaking down of which some force would have been required and some working in the dark called for, I have been induced to increase the length of the wound upward, even for an inch or two beyond the umbilicus, regarding such an increase of the incision as unimportant in comparison with the evil effects of violence and dragging upon the tumor for the purpose of its removal, or the blind tearing down of the abdominal or visceral adhesions which detain the growth.

I have never seen any evil effects from the long incision when made under the circumstances I have just indicated, but have, beyond doubt, seen the bad results of an opposite practice, of violence which has been employed in an attempt to remove a large growth through a small opening, or to tear an adherent one from its abdominal or visceral connections.

The incision should also always be made sufficiently low. If too high, considerable traction upon the pedicle of the tumor must be made to bring it into sight, and with the tumor the uterus will also be drawn out. This traction is always injurious, and should be avoided. When the lower end of the wound is too high up, this traction of the parts becomes unavoidable; by extending the incision downward toward the pubes to a point corresponding to the upper part of the healthy uterus, or about one inch above the pubes, this evil can be prevented, and, consequently, the practice I have just advised should invariably be adopted.

Tapping the Cyst.—The cyst, having been exposed, ought to be tapped, and for this purpose the instrument represented in Fig. 451, as made for me by Mr. Millikin in 1864, is the one I prefer. It includes not only a trocar and canula, but a vulsellum forceps, which slides upon the latter, and by being made to grasp the cyst walls holds the instrument firmly in its position, thus enabling the surgeon to make traction upon the tumor for the purposes of its removal.

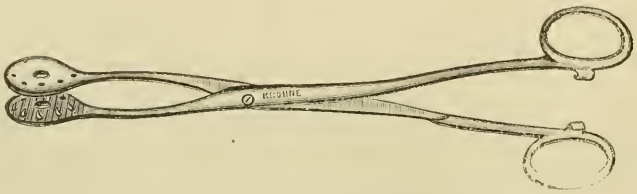
Fig. 451.



Trocar and Canula for Tapping, with Movable Forceps.

Removal of Cyst.—When the cyst has been emptied and is of a simple nature, its removal, unless adhesions exist, is readily effected; but when it is solid or very compound, it may be necessary, to allow of its extraction, to lessen its size by breaking down its contents, and for this purpose the surgeon must make a free opening into the cyst and introduce his hand into its interior, the orifice of the opening into the cyst at the same time being held well open and forward by forceps (Fig. 452) adapted for the purpose.

Fig. 452.



Nélaton's Cyst Forceps.

By these means the most compound cyst may be broken down and removed. When the cyst is so adherent to the abdominal parietes as to render it difficult for the surgeon to

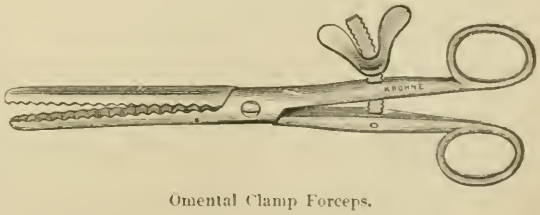
distinguish the cyst wall itself from the parietal layer of peritoneum, the plan adopted by Sir Spencer Wells, of emptying the cyst and seizing its posterior or upper wall from within by forceps and inverting it, is a good one, the cyst then peeling off on good traction being made.

Adhesions and their Treatment.—When the incision through the abdominal walls has been made and the smooth glistening surface of the visceral peritoneal covering of the tumor recognized, the surgeon may be satisfied that the abdominal cavity has been fairly opened and the tumor exposed; and when the ovarian cyst on each respiratory act is seen to move freely within the abdomen, there is a strong probability, if not certainty, that the tumor is free and the complication of adhesions is not likely to be severe; for when the tumor is fixed to the abdominal walls, this mobility of the cyst is not present. Fibrous or fibro-cystic tumors of the ovary or uterus usually have a fleshy or muscular appearance. Adhesions may present themselves on the completion of the abdominal incision in three forms—*first*, as forming a complete and compact union between the peritoneal covering of the cyst and the abdominal peritoneum; *second*, as loose and fibrous connective bands; and *third*, as visceral adhesions. When a firm and compact union exists between the cyst and the abdominal peritoneal membrane, the surgeon will have lost his chief guide as to the depth of his abdominal section, and under these circumstances he may experience some difficulty in deciding whether the abdominal cavity has been opened or not; he must consequently be careful in his procedure, for he is not far from the possibility of perpetrating a fatal error—the separation of the parietal peritoneum from its muscular connections; but this error, however, can be avoided by merely extending the abdominal incision upward until the distinct line of separation between the cyst wall and the abdominal peritoneal membrane is clearly seen. The next step of the operation consists in the breaking down of adhesions, which may be done by the careful introduction of the finger between the cyst walls and the parietal layer of peritoneum. And here some force is perfectly justifiable; for if the adhesions are confined to the abdominal parietes and can be torn through, there is rarely much subsequent danger to be apprehended. Extreme care, however, is required at this stage of the operation. The surgeon, by the introduction of his finger, should make out the extent of the adhesions and test their strength. If they should be found numerous and too firm for separation, the operation at this stage had better be abandoned and the wound closed; or should many visceral adhesions of a firm character be present, it would be well to follow the same practice, as the latter are much more dangerous than those merely attached to the abdominal walls. It is, indeed, difficult, if not impossible, to describe with anything like accuracy what extent or character of adhesions would justify the surgeon in abandoning an operation once begun and then closing the wound. The careful study of reported cases and experience alone will enable him to decide with certainty upon these points. Yet, as a broad rule, it may be asserted that, while parietal adhesions may be fearlessly treated when they can be divided, those connecting the cyst with the viscera and the pelvis should always be regarded with alarm, and that the amount of force permissible in the treatment of the former class of cases would be quite inexcusable when the viscera are concerned. Wells's method of emptying the parent cyst, passing one hand into its interior, grasping its back, and inverting it, the back part of the cyst being withdrawn through the opening made in its front, is an excellent one.

The fear of hemorrhage from the lacerated adhesions should always be present to the surgeon, and the torn surface should be carefully examined with a view to the arrest of any bleeding.

Omental adhesions should be particularly examined with care and torn through with caution, for they are very vascular and cannot be treated with too much consideration. As a rule, they should be divided and secured with a fine ligature of silk or carbolized catgut. Their forcible separation is always bad. Spencer Wells's forceps for holding the omentum (Fig. 453) whilst the surgeon secures the vessels is invaluable. Firm band-like adhesions may be similarly treated. The ends of each ligature may be cut off and the knot left in.

Fig. 453.



Omental Clamp Forceps.

When the incision has been made and no adhesions exist between the cyst and the internal abdominal walls, it appears to be

an unnecessary practice for the operator to introduce his hand into the abdominal cavity with the view of learning whether they exist or not. Adhesions in front must necessarily be broken down, and this can generally be effected by the finger of the operator introduced at the margin of the wound. As the cyst empties these adhesions are necessarily brought forward; but when they do *not* exist, the peritoneum escapes even the touch of the hand of the operator. In complicated and exceptional examples of this operation it is clear that this practice cannot be followed, but in the more ordinary and simple cases it is most applicable. In many examples which have come into my hands the value of this advice has been well proved, for in them the peritoneum was touched only by the knife and needle.

As the tumor is being extracted care should be observed to guard against the protrusion and exposure of the intestines and omentum, and this is best done by the introduction of flat sponges, a sponge being tucked in and spread out beneath the parietes as the process of extraction of the cyst and exposure of the pedicle is going on.

Treatment of the Pedicle.—At the present day the pedicle is, as a rule, tied in two or more segments, according to its size, with carbolized silk, the ends of the ligatures are cut off close to the loop, and the pedicle with the ligatures is dropped back into the pelvis. This method is doubtless a great improvement upon the clamp and other forms of practice.

In France, Maisonneuve twisted off the cyst by continued torsion, leaving the pedicle to fall back into the abdomen, whilst Nélaton preferred to fix the pedicle externally and secure it by means of a common clamp. In Germany, Martin and Langenbeck cut through the peritoneal covering of the pedicle by a circular incision, cut off the tumor, tied each vessel separately, and fixed the pedicle to the walls of the abdomen by means of a double ligature. Dr. C. Clay fastened the pedicle by a double ligature, cut off the tumor, and, having allowed the pedicle to drop backward into the pelvis, brought the ends of his ligatures out through the lower ends of the incision. Dr. Tyler Smith followed the same treatment, but dropped both pedicle and ligatures, which are cut off close, into the pelvis, and then closed the wound. S. Wells and T. Keith for years fixed the pedicle externally by means of a clamp, but Wells, Thornton, and most operators now use the ligature, and Keith the cautery, as first employed by Mr. B. Brown and Sköllberg, dropping the cauterized end of the pedicle back into the pelvis. Atlee of America employs the écraseur. In my own practice I now always employ the ligature.

The plan of treatment now principally adopted, of dropping in the pedicle with the divided ligature, was first practised in 1829 by David Rodgers of New York. His patient made a good recovery. The practice did not, however, meet with general approval. It was too bold and inconsistent with all past experience and professional prejudices, and fell to the ground. It was repeated at intervals by other surgeons with tolerable success; it has now gained a strong hold on the professional mind and become a general practice. I may mention here that Sir B. Brodie had some confidence in this practice, for in 1843, when discussing the case upon which Mr. Aston Key had operated without success at Guy's Hospital, he expressed his belief that the right treatment of the pedicle was to drop it in and close the wound, and that if success could be secured it would be by such means. I make this statement on the authority of Dr. H. Oldham, who heard the remark.

What becomes of the ligated pedicle with the ligature or of the cauterized extremity is a point of interest, and it may with some confidence be said that the ligated or cauterized end does not slough, nor does the ligature act as a foreign body. In a case of my own in which the pedicle was secured with carbolized catgut and dropped in with a good result no traces of the ligature were visible a year later, when the patient died from some cause other than the disease; indeed, there was not even an adhesion, for the fimbriated end of the divided pedicle was free.

Dr. Doran[1] has also found, from a careful examination of ten cases at variable periods after ovariotomy, that "a communication between the distal and proximal parts of the stump is established by inflammatory plastic effusion, and the ligature is unravelled by granulation cells insinuating themselves between its fibres."

Toilet of the Peritoneum.—When the pedicle has been secured, all bleeding points should be carefully looked to, particularly at the seat of adhesions, and all vessels should be twisted or ligatured with fine carbolized silk or catgut.

The second ovary, with the uterus, should then be examined, and the pelvis thoroughly cleaned with soft sponges. Indeed, the greatest care should be observed in what

[1] *St. Barth. Hosp. Reps.*, vols. xiii. and xiv.

is called the "toilet of the peritoneum," so that blood clots and fluid should be carefully removed. In my early days I, in common with others, did not see the necessity of this care. When this important measure has been completed, a flat sponge should be introduced within the wound and left till the sutures have been introduced.

Treatment of the Wound.—The operation completed, the abdominal cavity cleansed, the opposite ovary examined, and all signs of hemorrhage absent, the surgeon may then proceed to the closure of the wound. He should do this by means of deep and superficial sutures; those of silk plait, as sold by fishing-tackle makers, are the best. These sutures should be inserted at intervals of an inch and made to include the muscles and peritoneum, intermediate superficial sutures being inserted through the skin. When union has taken place—*i. e.*, any time between three and six days—the sutures should be removed, no object being gained by leaving them longer *in situ*.

Drainage Tubes.—In all complicated cases where the peritoneum has been much involved and there is a probability of hemorrhage or serous exudation, a drainage tube should be introduced at the lower angle of the wound. One made of glass is better than the india-rubber.

After-Treatment.—Whenever a patient has taken an anæsthetic, it is wise to keep the stomach as quiet as possible, and, as the benefit of an opiate after the operation is always great, it is wise to administer it by the rectum. In abdominal operations this practice is of great value, and for some years I have been accustomed to give a half grain of morphia suppository after every ovarian operation, as well as after others of hernia, ruptured perinæum, etc. The suppository should be administered before the patient has recovered from the effects of the anæsthetic, and care should be taken that it be passed well into the rectum. If pain is felt, the suppository may be repeated; but it is rarely necessary to administer it more than once a day—namely, at bedtime. The patient's room should be kept cool and airy, as in other cases of operation. For the first two days milk or barley water forms generally the chief diet; but should sickness supervene as a result of the anæsthetic, ice and milk or ice and soda water should be administered, and everything should be cold. If sickness continues, food ought to be given two or three times a day by the rectum. As soon as the stomach will admit, fresh meat, brandy, and wine ought carefully to be given, the object being in these cases, as in all others of general surgery after the first three days, to keep up the powers of the patient, and so enable nature to complete the cure. The application of a Leiter's coil to the abdomen I have found of great advantage, and an ice cap to the head is beneficial when the temperature rises above 102°. The urine ought to be drawn off periodically; and when the bowels require relief, their action should be rendered easy by the use of enemata. The bladder should never be allowed to become distended or the bowels be left loaded too long.

On the use of opium a few remarks remain to be made, for upon this point the practice of surgeons appears to be undergoing a change. In the early operations of ovariotomy it was extensively employed, and at the present time some are still free with its use; but there is good reason to believe that in this operation, as in others, a very free administration of the drug in every case is not attended by such good results as could be wished, and that in a patient under its full influence a wound does not repair so rapidly and favorably as in another where natural processes are allowed to progress without interference. Opium carefully given to allay pain and cause sleep is a drug concerning the value of which there cannot be a doubt, but opium administered with sufficient freedom to bring, and repeated often enough to maintain, a patient under its influence is a drug against the use of which a surgeon should be on his guard. In ovarian cases it ought not to be given in larger quantities than sufficient to allay pain and secure sleep. A patient should not be kept under its full influence unless there are specific reasons for it. It is best administered by the bowel, being less liable to cause injurious effects and more likely to produce good, since it is absorbed as rapidly by the rectum as by the stomach; and in abdominal operations it tends much to maintain that quietude of the bowels which in all such cases is so desirable. In my own practice I have been accustomed for some years to administer opium by the bowel in preference to the stomach in all cases of abdominal surgery.

After the operation of ovariotomy patients may become pregnant. Many of mine have done so, and in one case, recorded in the *Gaz. Méd. de Paris* (1873), a patient had twins—one male, and the other female.

Ovariotomy in Pregnancy.

Ovariotomy may even succeed when performed upon a pregnant woman. Sir Spencer Wells has reported 9 such operations, with 8 recoveries. In 5 of the 9 cases pregnancy proceeded, and living children were born after natural labor; and in all these the operation was performed within the fourth month. In the other cases a miscarriage occurred. He lays it down as a rule that in cases of multilocular or solid tumor the tumor should be removed in an early period of pregnancy; and if an ovarian cyst should burst during pregnancy, removal of the cyst and complete cleansing of the peritoneal cavity may save the life of the mother, and pregnancy may go on to the full term.

Treatment of Suppurating Ovarian Cysts.

When an ovarian tumor is breaking down and undergoing disorganizing or suppurative changes, whether spontaneously or after tapping, it has been already stated that it is the surgeon's duty to interfere and to remove what is a serious source of constitutional irritation, and one which, if left to itself, must to an almost certainty destroy life. This should be done by means of an exploratory operation. When the tumor can be removed as a whole, so much the better; but when it has contracted such adhesions with the parts around as to be practically immovable, as much of the tumor should be turned out of the parent cyst as possible and the cyst itself stitched to the margins of the wound, the suppurating cavity being well washed out once or twice daily and a drainage tube left in. I have recorded an excellent example of this practice in *Guy's Hosp. Rep.* for 1868, where a woman æt. 34 was successfully treated by these means, and more recently, in 1874, I removed a suppurating ovarian cyst associated with acute peritonitis with a successful result.

The strangulation of ovarian tumors by rotation is not rare. Rokitansky in 1865 published a paper upon it. It means that under certain circumstances the movable ovarian tumor may rotate more or less upon its axis, and so twist the pedicle. If the twist happens to be slight, no important interference with the circulation of the vessels through it may be brought about; but if it should be enough to prevent the return of the venous blood from the ovary, congestion of the part strangulated, followed by exudations of serum, and possibly of blood, will follow, which give rise to symptoms not unlike those of strangulated bowel. Indeed, cases of this kind have been regarded as such. In Ann R——, æt. 28, under my care in February, 1884, the difficulties of diagnosis were great, the onset of the symptoms having been sudden, the local pain severe, and vomiting persistent. The symptoms had appeared after a railway journey. I operated at once, and removed a large polycystic tumor which was black from congestion and with a Fallopian tube rigid with blood; also some blood from the peritoneal cavity. The pedicle was bloodless where twisted. Had relief not been given, the whole tumor would have become gangrenous. As it was, the patient made a rapid recovery.

Wells reports two cases of sudden death from hemorrhage into the peritoneal cavity from this cause.

Hysterectomy.

Operations upon the uterus have been gradually growing in favor, and the fact is probably due to the experience which ovariotomists have accidentally acquired in the removal of uterine tumors which have been mistaken for ovarian. They are now frequently undertaken for cystic disease of the uterus and fibroid tumor, whether growing as pedunculated, subperitoneal, or intramural growths, and much success has attended the practice.

The operation has likewise been undertaken for cancer, but experience has not given much support to the measure.

For fibro-cystic tumors the operation is a good one, for these growths steadily increase, and do not, as the fibroids, cease to grow when menstruation has passed away.

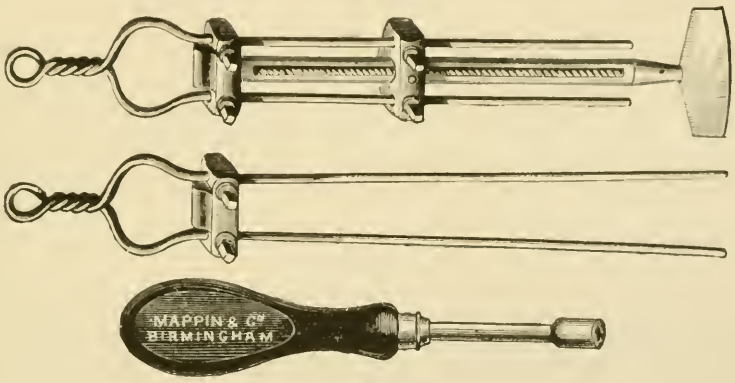
Fibro-cystic uterine tumors present all the external features of the more solid ovarian and cannot be diagnosed, more particularly when a pelvic examination reveals but little. When the uterus can be made out to form part of the tumor and to move with it, when the uterine sound can be passed freely into the cavity of the uterus and be made to extend far beyond its normal distance, when at each monthly period the flow is profuse, when the tumor is fixed well in the pelvis and the abdominal veins, etc., are turgid from its mechanical pelvic pressure,—something more than a suspicion of its fibro-cystic nature

may be formed; but when none of these symptoms are present, the diagnosis cannot be made with certainty.

The operation of extirpation of the uterus has been performed with success by Clay of Manchester, Storer of Boston, Koeberle of Strasburg, Schroeder of Berlin, Keith of Edinburgh, Wells, Thornton, Tait, Davies-Colley, and myself. My own case was in the person of Miss M——, æt. 26. The tumor had been growing for three years, and for this she had been under the care of Dr. Oldham, who believed the case to be one of ovarian disease. He sent her to me for operation. On May 19, 1871, I operated, and, finding the uterus and both ovaries diseased, I removed the whole, fixing its base with a large clamp. An uninterrupted recovery took place. Full particulars will be found in the *Trans. of Obstet. Soc.* (1873).

I have operated on three other cases, but not successfully, one patient dying from hemorrhage caused by the rupture of a pelvic vein and the others from the shock and peritonitis. In two I removed the uterus and its tumors by means of the chain écraseur made by Meyer of Great Portland street. The chain should be passed well round the base of the growth and screwed up slowly. I would, however, now use Lawson Tait's clamp (Fig. 454).

Fig. 454.



Tait's Clamp.

Operations for *uterine fibroids* have been more frequent than for cystic uterine disease, and likewise more successful. They should not, however, be undertaken unless the tumors form decided obstacles to the patient's progress through life, or give rise to troublesome hemorrhage. Many of these tumors cease to grow or to be a source of trouble after the menopause, and many never interfere even with a woman's comfort.

In 1873 I removed a sessile fibrous tumor the size of a large cocoanut from the right cornu of the uterus at the same time that I removed a large ovarian tumor from the left ovary. The lady, æt. 51, was a patient of Mr. Collambell of Lambeth, and recovered.

Mr. Thornton, who has had good experience of this operation, states "that large pedunculated subperitoneal fibroids, when diagnosed, should be removed, even though they may only cause inconvenience at the time." He adds, however, that "operations for intramural fibro-myomata are specially dangerous, since they naturally involve the opening of the uterine cavity." The operations are far more formidable than ovariotomies. "If you have to think twice," writes Keith, "before advising a woman to have ovariotomy done, you must think fifty times ere you recommend her to have a uterine tumor removed." Neither Wells nor Thornton advocates their removal indiscriminately, but rather the adoption of Battey's operation or the removal of the uterine appendages to check the growth of the tumor when it gives rise to troublesome hemorrhage.

Thornton has performed Battey's operation fifteen times, and with success, ten of the patients having lost their tumors; in two the tumors are lessening, and the remaining three are recent cases.

Lawson Tait has ably advocated this same measure, and has had much success. He writes that the operation for the removal of the uterine appendages for uterine hemorrhage, when associated with uterine tumors, has been accepted.

Operation.—In a general sense the same principles of practice are applicable to these cases as to those of ovarian disease. The one difficulty is the treatment of the pedicle where such exists, or of the divided uterus.

When a fibroid tumor is pedunculated, there is no difficulty, as the pedicle may be tied in halves and dropped back, as in an ovarian tumor. When it is large and, thick, possibly Thornton's method is very applicable, as described by him (*Brit. Med. Journ.*, October 13, 1883):

"If the pedicle be transfixed, hemorrhage from the puncture is liable to occur and very difficult to control. I therefore first secure the pedicle by a ligature tied firmly round the whole of it, then, threading an end of this ligature through the needle again, transfix the pedicle on the distal side of the first tie and proceed to ligature in halves or smaller pieces if necessary. This method renders slipping of the ligature impossible."

Under the above circumstances the pedicle may be dropped back and the abdominal wound closed.

This practice must not, however, be adopted when the uterine cavity is exposed. Under such circumstances the pedicle should be kept outside the abdominal walls. Sir Spencer Wells uses for this purpose a stout pin about the size of a penholder, around which he twists a figure-of-8 ligature, the two acting together as a clamp. Koeberle employes his *serre-nœud*, and it is useful: but Lawson Tait's clamp is probably better, as it can secure a pedicle of any size and hold it securely. Indeed, when a clamp is wanted for any operation, no better can be used (Fig. 454). Should there be any fear of the clamp slipping, one or two pins may be passed through the distal side of the pedicle to make it secure.

Hegar of Freiburg (*Berlin klin. Woch.*, No. 12, 1882) recommends the use of the elastic ligature in the removal of abdominal tumors and organs. He has removed uterine fibroids by this method without hemorrhage. From many experiments he thinks it is evident that uterine pedicles can be treated without danger by the elastic ligature.

Carl Schroeder of Berlin, when removing his intramural fibroids, uses an india-rubber ligature as a temporary clamp, enucleates the growth, and stitches together the capsule of the growth with different layers of sutures, one suturing the mucous membrane of the uterine cavity and the other the peritoneal layer, subsequently draining the cavity through the vagina.

Out of 66 patients operated on by him, 20 died, or 30 per cent. Of his last 40, he, however, lost but 9, or 22.5 per cent.

L. Tait has had 28 cases, with 6 deaths, or 21 per cent. Spencer Wells has had 39 cases, with 21 deaths, or 53 per cent. Keith has had 17 cases, with 1 death.

This operation of hysterectomy is the gravest the surgeon can undertake; when complicated, it tries him to the utmost. Let it not be undertaken rashly or without the fullest consideration.

THE SURGERY OF THE MUSCULAR AND OSSEOUS SYSTEMS.

CHAPTER XXXIII.

AFFECTIONS OF THE MUSCLES AND TENDONS.

Contusions.

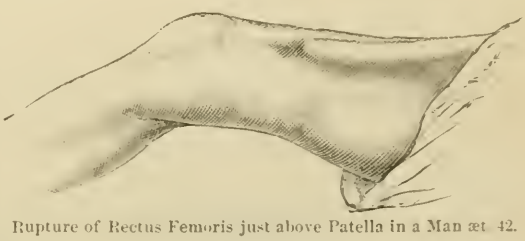
Contusions of muscles, as of other parts, may occur, and when severe may be followed not only by want of power, but by absolute wasting. Thus, in 1863 I saw a man æt. 44 who five months before received a severe contusion of the left deltoid muscle from a fall upon the shoulder, and as a consequence the muscle had completely atrophied, although there was no loss of sensation over the muscle and in all other respects the limb was normal.

When wasting takes place, the muscle should be stimulated by galvanism before degeneration has proceeded too far. When due to the want of nerve force, there is little hope of any good result being obtained under any treatment.

Subcutaneous rupture of muscle to a slight degree is far from being uncommon, particularly of the deltoid; but its complete rupture is very rare. In most cases of strains some rupture of a muscle takes place, which often shows itself by the effusion of blood into the part.

At times a muscle is torn across by overaction, as in tetanus, the rectus abdominis being that most frequently affected: but the psoas has been said by Mr. Earle to be so injured. Sédillot reports that out of 28 cases of ruptured muscle, 13 occurred at its point of juncture with the tendon. He says, also, that rupture occurs only in some involuntary action of the muscle or when it is taken unawares. In 1859 I attended a man æt. 21 who ruptured the left rectus abdominis above the umbilicus when jumping with some bricks in his hand. He was collapsed after the accident; and when I saw him, the next day, the two ends of the muscles were so far asunder as to allow the fingers to be placed between them. In 1863 I also attended a man æt. 65 who, when lifting a cask with his body bent, felt an acute pain in the posterior part of one thigh, "as if he had been struck with a potato;" he fell forward and was unable to walk. When I saw him, two days after the accident, the semi-membranosus muscle had clearly been divided at its origin from the tuber ischii; the body of the muscle could be felt as a loose, fleshy mass, and below the tuberosity of the ischium a marked deficiency was present. I have also the notes of a case of complete laceration of the extensor triceps muscle of the thigh above the patella in a railway inspector, who said that it gave way with a report on his attempting to start off suddenly for a run. In this case there was great effusion of blood into the part within a few hours, which had subsided after the application of ice, the separation of the muscle from the patella being very distinct. In the drawing (Fig. 455), rupture of the rectus femoris is illustrated, and was taken from a male patient æt. 42.

Fig. 455.



Rupture of Rectus Femoris just above Patella in a Man æt. 42.

Minor degrees of laceration of muscles are of common occurrence, often followed for

many months by pain, stiffness, and want of power in the part, the pain disappearing for a time to reappear on any overaction of the weakened muscle. These pains are often called "rheumatic."

In his Fothergillian prize essay Mr. Poland records two cases of complete rupture of the rectus abdominis muscle in the hypogastric region, so that the finger could be laid in the dents between the retracted ends. Both occurred in the wards of Guy's Hospital and in men of advanced years suffering under organic disease; the one had an advanced stage of bladder and kidney mischief the sequelæ of old stricture, the other was suffering from a relapse after continued fever. In both the accident had been caused by a fall across the iron rods of the bedstead in a vain attempt to rise and walk. Both died a few days after the accident, when complete rupture of the rectus was found in the middle of the hypogastric region, and coagulated blood existed between the divided ends, as if only just poured out. No signs of repair were present.

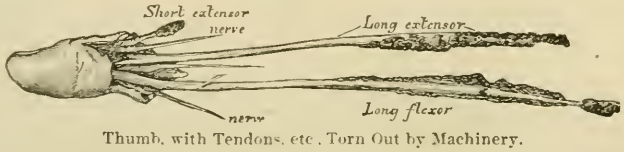
Treatment.—In all cases of completely ruptured muscle the parts must be relaxed, in order that the divided ends may be made to approximate as much as possible and be fixed at rest, so that repair may not be interrupted. When much effusion of blood or serum follows, ice may be applied in a bag: and when absorption has somewhat advanced, a stimulating liniment hastens recovery and gives comfort. When these are not attended to, repair cannot go on; indeed, as a consequence of neglect, suppuration is by no means a rare result, as is seen in psoas abscess. When the laceration has been complete, permanent weakness will remain; and when the abdominal muscles are at fault, some hernial protrusion of the abdominal contents will take place. In a man who fell from a ship's ladder upon a blunt-pointed iron bar, and had severe rupture of the abdominal muscles attached to the anterior half of the crest of the ilium, a large hernial protrusion existed and I could press my fist into the opening through the muscles. In such cases some artificial support is permanently needed.

Compound Laceration of Muscle.

When muscles are lacerated in connection with wounds of the soft parts covering them, the injury is grave, and the primary danger of the case, as well as the prognosis as to the future use of the part, turns upon the amount of laceration. In compound fractures, etc., this fact is well known.

But at times muscles are torn out through skin wounds or are ruptured at the time of the accident, and may even hang out of the wound. When this is the case, the muscle, unless much crushed or injured, must not be cut away, but replaced in position as well as possible; and to further this end the wound in the soft parts may be enlarged. One of the worst cases of this kind I have ever seen I attended with Dr. Mason of the Barbican. It was that of a gentleman æt. 22 who when sleep-walking fell a height of forty feet out of a window on a glass skylight. Among other injuries, he sustained a lacerated wound of his right thigh and complete division of the body of the inner hamstring muscles. When I saw him a large mass of well-developed muscle protruded from the skin wound. I enlarged the opening in the integument and carefully replaced the muscle, keeping the limb on a splint. In five weeks he was convalescent. A year later he had complete movement of his limb. Entire tendons are sometimes torn out of a limb, and in Guy's Hospital Museum there is a preparation (1367) which includes the last joint of the middle finger with its tendon of the flexor profundus attached. It was torn by a threshing-machine, the accident being followed by tetanus: yet the patient recovered. In another preparation (1119[65]), figured below (Fig. 456), there is a portion

Fig. 456.



Thumb, with Tendons, etc., Torn Out by Machinery.

of thumb with the long flexor and extensor and short extensor tendons, together with the nerves, torn out by machinery. It was taken from a man æt. 17 who made a good recovery.

Dislocation of Muscles and Tendons.

There is good reason to believe that muscles, like tendons, may be dislocated, although, from the way the former are protected by fascia and the latter by fibrous sheaths and bony grooves, such accidents are rare. When they occur, they are the result of some sudden and unexpected strain, rick, or twist. In the upper extremity the accident may occur to the biceps tendon and those about the wrist. I have never seen a dislocated biceps tendon, but must refer to an able article on the subject by Mr. J. W. White of Philadelphia, published in the *Amer. Journ. of Med. Sci.*, January, 1884. In the lower limb it may occur to the peronei tendons and tendon of the posterior tibialis, as well as to the conjoined tendon of the extensors of the leg attached to the patella, and to that of the sartorius muscle. Other tendons may also, doubtless, be dislocated.

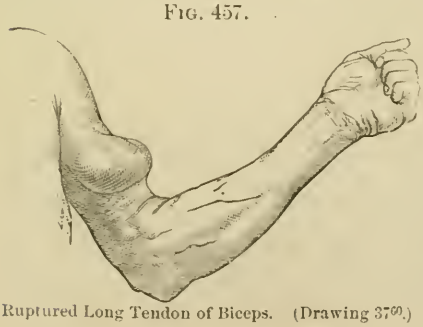
Whenever dislocation takes place, it can be recognized by the starting of the tendon from its anatomical position, as well as by the pain suffered on putting the muscle into action, the muscle necessarily acting at a disadvantage. The tendon in most cases may be readily reduced, but the greatest difficulty will be experienced in keeping it in position; indeed, it is a question whether the sheath of a tendon, when fairly ruptured, will ever unite or repair; yet the attempt to obtain it should be made. In a case of dislocation of the peroneus longus tendon the only treatment that gave permanent relief was its division, and, what is more, the foot was not visibly weakened by the operation. In 1869 I had under my care a woman æt. 29 with a well-marked example of dislocation of the peroneus longus tendon. Some ten days before I saw her, when walking, she felt a sudden pain behind the external malleolus which led her to think she had been struck with a stone. She was at once disabled and experienced severe pain in the part, and on rubbing her ankle at the time she felt a cord in front of the bone, which slipped in on moving the foot. Since that time any movement of the ankle caused the same cord to appear. When I saw her, by giving the foot the slightest twist the tendon of the peroneus longus muscle could be readily displaced from its groove behind the external malleolus and made to appear upon the bone, where it could be rolled under the finger. Its reduction was effected by abducting the foot, but it was kept in its position with great difficulty. For this purpose the best means were a good pad of lint fixed over and behind the ankle by means of strapping. I saw her a month after the accident, when she could walk without pain or stiffness; the tendon seemed fixed in its place, but the bandage and pad were reapplied and directions given to retain them for a month. I have likewise seen the tendon of the tibialis postieus displaced from behind the inner malleolus.

Dislocations of muscles are probably more rare than those of tendons, and, if not, are less recognized. They may be suspected to have taken place where, after a rick or strain, pain is produced when the muscle is put into action and the pain is fixed to a spot, when this pain is relieved by relaxing the affected muscles and kneading the part with the hand when so relaxed, and when, moreover, there is no external evidence of a bruise to suggest rupture of muscle. These cases should be treated by manipulation after relaxing the muscles, the surgeon with a strong and firm pressure manipulating the part at the seat of pain; subsequently, pressure should be applied and the muscle kept at rest for a sufficient time to allow the injured part to heal.

Rupture of Tendons.

This accident is more common than rupture of the body of a muscle, and a tendon usually gives way at its muscular or bony origin. It occurs chiefly in subjects past middle life. The long biceps tendon not rarely gives at its upper end; and when it does, it imparts to the biceps muscle, on contraction, a peculiar appearance, its inner or coracoid half contracting into a hard knot (Fig. 457), while its outer remains lax and but slightly altered. This swelling has been mistaken for tumor of the muscle of the arm. When the one tendon breaks, the other usually follows at a later date, thereby clearly indicating that they give way from some disease. In a case I treated in 1858 the two tendons gave way at the interval of four months, and the arm became black and blue after the

Fig. 457.



Ruptured Long Tendon of Biceps. (Drawing 37ᵒ.)

accident. The tendo Achillis rarely snaps. The plantaris does so occasionally, and causes a peculiar dragging of the foot and eversion. In the case of a man æt. 27 which I saw a few hours after the accident this symptom was so marked and peculiar as to make it quite pathognomonic. The rupture was caused by taking an upward step of two and a half feet into a vessel with a load on his back. The tendon gave way with a snap when in the act of raising the posterior part of the heel from the ground.

I have likewise the notes of a case of rupture of the tendon of the *biceps femoris* which took place in a boy æt. 8 who when hanging on behind a four-wheeled cab had one of his legs entangled in the wheel. When admitted into Guy's, directly after the accident, the tendon of the biceps femoris was made out to have been ruptured at its insertion into the fibula; there was a marked depression at this point, with ecchymosis. The limb was flexed and fixed on an outside splint, and a good recovery ensued, although there was some weakness of the muscles supplied by the external popliteal nerve, which had apparently been injured at the same time.

Looking upon the ligamentum patellæ as a tendon, the following example of its rupture may be recorded. In 1867 I was called upon to treat a man æt. 31 for an injury he had sustained to his right knee ten days previously while attempting to save himself from falling backward. The knee swelled after the accident and became acutely painful; and when I saw him the patella was drawn up for at least an inch, the ligament having been divided. I treated the case as for fractured patella, with a posterior splint, and employed pressure to bring the patella downward; but I was unable to alter its position to any extent. The man recovered, however, with a useful limb.

Wounds of Tendons.

When tendons have been divided in incised wounds, they separate, and their separated ends adhere to their sheaths, with the necessary consequence of impaired movements of the parts to which the tendon is attached. To avoid this, as a primary treatment of divided tendons the tendons should always be sutured with silk or catgut, the muscle with which it is connected relaxed, and the wound dressed for quick union, the part being kept in position by means of a splint.

In June, 1883, a woman æt. 34 had the extensor tendons of her ring and little fingers divided above the wrist. My dresser enlarged the wound lengthways, found the separated ends, and stitched them together with carbolized catgut. He then washed the wound with iodine water and dressed it with terebene oil. Good repair followed, with movement of the fingers.

In June, 1883, a man æt. 31 came under my care with a divided tendo Achillis from a broken water-jug. The ends of the divided tendon were separated for about two inches. My dresser, Mr. R. Knaggs, by my direction exposed the tendon fully by a vertical incision, washed the wound with iodine water, and sutured the tendon with one central suture of carbolized catgut and two lateral sutures of kangaroo tendon. He then extended the foot and fixed it on a splint. The wound was dressed with terebene oil. Quick union followed, and excellent repair, without suppuration. In two months the man had a sound leg and strong tendon, with perfect movement of the foot.

This practice of stitching important tendons ought always to be adopted.

There is good reason to believe that a divided tendon may be successfully cut down upon several weeks after its division and its ends sutured with a good result.

In wounds where muscles and tendons unite by granulations some stiffness and want of power in the part will remain for a long time, or even altogether. In healthy subjects it is remarkable how tendons at one time fixed subsequently free themselves from their surrounding attachments and become free again. This hope may always be held out to a patient who takes a gloomy view of his own prospects.

Inflammation of Muscle

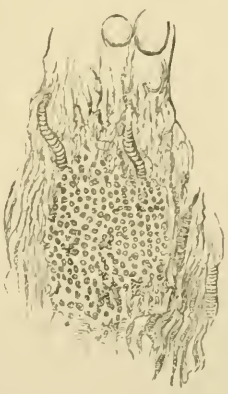
is a recognized affection, and occurs as a consequence of some strain or partial rupture of its fibres, as well as independently of any such cause. It is the more common as a result of injury, and is seen not seldom in the rectus abdominis as well as in the psoas muscle, in which, as a cause of psoas abscess, I believe it to be not rare. As a result of septicæmia it is frequently met with, and is found in every muscle, even the heart. It appears as a more or less acute affection of the muscle, and is accompanied by swelling, local pain, and constitutional disturbance; suppuration occurs in due time. The symp-

toms rarely come on directly after the injury, but probably after the lapse of several weeks, as a consequence of some want of repair in the injured part, and from the non-observance of the necessary rest which an injured muscle so much requires in the process of healing. When an abscess forms in a muscle, the sooner it is opened the better, recovery readily following, even when the disease is in such a muscular organ as the tongue.

Inflammation of muscle as an independent affection is generally chronic, and in adults is chiefly of syphilitic origin. In infants it is met with most commonly as an affection of the sterno-mastoid muscle, the body of the muscle wholly or in part appearing as an indurated mass. It is generally observed soon after birth, and may at times be traced to some injury sustained at that time. I have seen it in the offspring of syphilitic parents, but more frequently when no such history could be obtained. In fifteen consecutive cases, a syphilitic history was obtained only in one. These cases rarely if ever suppurate in infants, but under the use of warm fomentations and some simple tonic, such as cod-liver oil, proceed to a natural recovery. I have never seen a case fail to recover by these means.

In the *early* period of the disease the inflammatory product is cellular; in the *later*, fibrous. These points are seen in Figs. 458 and 459, which have been kindly made for me by Dr. Goodhart. They were taken from a patient of Dr. F. Taylor æt. 5 weeks who looked healthy, but had had "snuffles," slight fissuring of the anus, and superficial ulceration of the scrotum. There was no history or other evidence of syphilis in the parents. The child died from atelectasis. The tumor in the *left* muscle was only noticed in the fifth week after birth, and the *right* muscle was never noticed to be diseased. The case is reported in the *Path. Soc. Trans.*, 1875, vol. xxvi.

Fig. 458.



Showing the Early or Cellular Stage. (From the right muscle.)

Fig. 459.

The Late or Fibrous Stage. (From the left muscle.)

The student should remember that this affection appears as a simple induration of the muscle, and is, therefore, unlike any glandular or other affection.

Chronic inflammation of the sterno-mastoid is likewise met with in adults, and, I believe, chiefly as a consequence of syphilitic disease. It attacks the muscle in the same way as it does others, such as those of the tongue, the extensor quadriceps of the thigh, the triceps of the arm, the temporal, masseter, or other muscles, the muscle or muscles becoming infiltrated more or less diffusely with the well-known syphilitic inflammatory products. These tumors, when their nature is recognized and right treatment is employed, can be reabsorbed; but if neglected and left alone, after attaining their full size, which is rarely great, they break up and suppurate, giving rise to deep-seated abscesses, which when they have discharged externally leave deep, irregular, excavated sores. In the tongue they simulate closely cancerous sores, many of the cases of supposed cured cancer of the tongue being, doubtless, of this origin. In other parts they have much the aspect of the deep cellular membranous ulcers which have been already described. As a part of syphilis they always appear late in its course and remote from the primary inoculation. When they appear in the adult, in the sterno-mastoid muscle, they more frequently attack its sternal end than its body.

After the disease has ceased atrophy of the affected muscle is a common consequence. Contraction occasionally follows, though I have never seen it. MM. Ricord and Notta have, however, recorded examples.

Recognizing the syphilitic nature of this affection, the treatment should be conducted on the usual principles; large doses of the iodide of potassium—say fifteen to thirty grains—may be given three times a day with advantage, not in such full doses at first, but by gradual increase from one to five grains. Mercury may also be given, the mercurial suppository once or twice a day being the best form. In the chapter on Syphilis this practice will be found described in detail.

Atrophy of Muscle.

The surgeon can see this under a great variety of circumstances. He is the most familiar with it as a consequence of want of use in disease of the joints or any other affection in which the limb is kept at rest, and under these circumstances the muscles simply waste; they undergo no other change in structure and are capable of complete restoration on reassuming their normal action.

In a large number of cases of infantile paralysis the same thing may also be said, for under the stimulus of galvanism or the continuous current, persevered in for many months, the thinnest limbs plump up and the feeblest muscles become capable of performing the work for which they were intended. Indeed, in those cases where deformity does not complicate the case a good result may be looked for.

After fevers, lead poisoning, rheumatism, scrivener's palsy, and alcoholism the muscles may undergo genuine degeneration, either granular, fatty, or waxy, and according to Lockhart Clarke "there is another form of this malady, which is known by the name of *progressive muscular atrophy* (Cruveilhier), *atrophie musculaire graisseuse progressive* (Duchenne), and *wasting palsy*. This curious disease differs in several respects from the other atrophies. It is always chronic, but of uncertain duration, is frequently hereditary, capricious or irregular in its invasion, prone to spread from one part to another or become general and thus go on to a fatal termination. The affected muscles suffer different degrees of wasting and assume a variety of aspects. Even in the same muscle bundles in different stages of atrophy and degeneration may be found at the side of others that have retained their normal state. When the wasting is extreme in all the bundles, a long muscle may be reduced to a mere fibrous and cylindrical cord or to a kind of tendon, and a flat muscle may be reduced in the same manner to a kind of membrane. In some instances the atrophy may be *simple*—that is, the muscular tissue may be wasted to a considerable degree without any granular or fatty degeneration; but generally one or both of these alterations of structure are found to exist to a greater or less extent. The muscle also changes and varies in color according to the nature and degree of the atrophy. It is paler than natural; occasionally it is quite colorless, like the flesh of fish, or it may have a faint yellow or ochreous tint. Its consistence for the most part is increased in consequence of the increase in the interfibrillar connective tissue. When examined under the microscope, the affected muscles may be seen to have lost to a variable extent and degree, or even entirely, the appearance of transverse and longitudinal striation, while in a corresponding proportion the sarcous or muscular element is transformed into granules, which in some instances are too fine to be distinguished as separate particles. The granules are soluble in acetic acid. In this odd affection the granular, fatty, and waxy degenerations are found side by side" (*Holmes's Syst.*, 3d ed., vol. ii. p. 163).

Symptoms.—This disease is said to appear more commonly in the hand and right upper extremity, progressing upward to the trunk, and then over it to the lower extremities. It rarely commences in the lower limbs. It begins with loss of power in the part, this loss gradually increasing, but rarely with any loss of sensation. Want of muscular co-ordination soon appears, as well as awkwardness in the patient's movements, and cramps, twitches, and fibrillary tremors take place, occasionally with pain or some cutaneous anæsthesia. Cruveilhier believed that atrophy of the motor nerves was the starting-point of this disease, but this theory is not now entertained. Lockhart Clarke says, "In 1861 I discovered in the spinal cord removed from a well-marked case of this disease numerous lesions of the gray substance, consisting chiefly of areas of what I call granular and fluid disintegration; and I have seen the same in other cases since." This view is taught by Trousseau, Duchenne, Meryon, Roberts, Cohn, and others.

This disease is generally hereditary, more common in males than in females, and is excited by excessive muscular exertion, cold, and damp, as well as by injuries or disease of the spine, syphilitic or otherwise.

Treatment.—Removal of the cause is the primary object; and when syphilis is suspected, special treatment should be employed. Tonics are always of use, and arsenic in Dr. Meryon's hands has met with good success, "but of all remedies hitherto employed galvanism is undoubtedly the most useful when applied to the affected muscles," while Clarke states that setons and blisters to the spine may be employed in the early stage.

Degeneration of muscles with apparent hypertrophy—called "Duchenne's disease," after its first describer, in 1858—is a strange affection which attacks children, but continues to affect them for many years of their youth. I have

grouped it amongst the affections of the muscles, but the observations of Dr. L. Clarke (*Med.-Chir. Trans.*, vol. lvii., 1874) clearly place it amongst the neuroses. It begins with weakness of the lower limbs, which is lasting and passes on to a progressive enlargement of the gastrocnemii, then of the glutei and lumbar muscles, and occasionally of all the muscles. These feel firm and elastic, and hard on contraction. After a variable period—at times years—the paralysis gradually increases and becomes more general. "The patient is no longer able to stand upright, the upper extremities become affected, the enlarged muscles rapidly decrease in volume, and the limbs and trunk become atrophied *en masse*. In this state the patient may exist for a considerable time, but he ultimately dies from intercurrent disease. Many of the children affected with this singular disorder have dull intellects and are more or less idiotic" (Clarke). Pathologically, great hypertrophy of the connective tissue of the muscle is to be found; the fibres themselves show finer striæ and are transparent, and large collections of fat cells also exist. Neither medically nor surgically does any treatment seem to be of benefit.

Writer's Cramp,

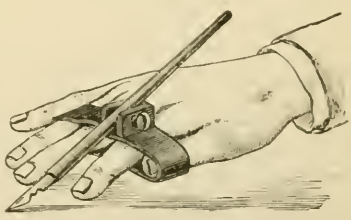
or scrivener's palsy, is a good example of what Duchenne has called "functional impotence," and it is doubtless due to overuse or exhaustion of the muscles employed. It begins as an aching of the hand after prolonged writing, with diminished facility in the act. After a time the pen is held in odd ways and with unusual tightness, but in spite of this it often falls from the hand. The whole fore-arm or arm soon shares in the trouble, and the difficulty in forming letters rapidly increases; tremors of the hand at times occur. At last the handwriting becomes illegible or the patient loses all power even of making his mark. With these local symptoms there is often severe headache or backache, and at times great mental distress.

In the majority of cases the inability to write is the sole trouble, but in many there is equal difficulty in adapting the muscles of the hand to the performance of any delicate action.

The affection is to be treated by rest, as guaranteed by a splint, and later on, when pain has passed, by gentle galvanic stimulation.

As a help to sufferers the instrument figured (Fig. 460), and suggested by Nussbaum of Munich, seems of use; the eminence of its introducer is a guarantee of its value. It is framed upon the opinion that, whatever the site of the malady, there is always spastic contraction of the flexors and adductors, with a weak condition of the extensors and abductors. With the bracelet put on as seen in the figure, these last muscles are strongly put into use, since the instrument can be worked only by abduction of the thumb and the extension of the digital muscles. The patient may write with the instrument as much as he likes.

Fig. 460.



Nussbaum Instrument for Writer's Cramp.

Tumors in Muscle.

These are of rare occurrence and always of a serious nature. They are mostly of the fibrous or fibro-cartilaginous kind. In 1866 I excised one of two years' growth from the fleshy portion of the external oblique muscle of a woman æt. 31 (*Path. Soc. Trans.*, vol. xviii.). The tumor separated the fibres of the muscle which it infiltrated, and microscopically it had all the elements of the fibro-plastic tumors. It returned within the year; and when I last saw the patient, in 1869, there was a second growth, the size of a cocoanut, occupying the place of the original tumor. In 1868, with Dr. Burchell of Kingsland, I removed from the abdominal muscles of a woman æt. 33 a myxomatous tumor eight or nine inches in diameter, of two years' growth.

Cancerous tumors may originate in, but more frequently infiltrate, muscles as secondary growths or by extension from other parts. Surgeons see them in the pectoral muscles in acute or neglected cases of cancer of the breast; in the periosteal cancer of bone, as well as in other parts. In the tongue and lip they may be regarded as new growths.

Hydatids, likewise, are found in muscles, as in every other tissue, as painless, tense, globular swellings. So also is that curious nematode worm the *Trichina spiralis*, which

in man seems to be taken into the body through eating the insufficiently cooked flesh of animals infested with it, particularly that of pigs.

"Trichinæ, as ordinarily observed in the human muscle, present the form of spirally-coiled worms in the interior of small, globular, or lemon-shaped cysts; which latter appear as minute specks scarcely visible to the naked eye. These specks sometimes resemble little particles of lime, and are more or less calcareous externally according to the degree of degeneration which their walls have undergone; these cysts are not, however, essential" (Cobbold).

When these worms are present in large numbers in the body, they give rise to a disease known as "trichiniasis," which is most fatal. Dr. Boehler and Königsdöffer of Central Saxony, who first saw this disease according to Leuchart, who described it, state that "the affection began with a sense of prostration, attended with extreme painfulness of the limbs, and after these symptoms had lasted several days an enormous swelling of the face very suddenly supervened. The pain occasioned by this swelling, and the fever, troubled the patients night and day. In serious cases the patients could not voluntarily extend their limbs, nor at any time could they do so without pain; they lay mostly with their arms and legs half bent—heavily, as it were, and almost motionless, like logs. Afterward, in the more serious cases, during the second and third week an extremely painful and general swelling of the body took place. A large proportion of the cases died. Dr. Thudichum has given an able report on this subject in the *Medical Officers' Report* to the Privy Council (1864).

Vascular tumors of muscle have been made the subject of a special paper by Mr. C. de Morgan (*Brit. and For. Med.-Chir. Rev.*, 1864), and Mr. Teevan has published an able paper on tumors in muscle in the same review for 1874. These, however, are very rare. The vascular tumors of erectile tissue attack a muscle either as a diffused or encapsuled growth or as tumors having the appearance of varicose veins around the muscle. They are chiefly, though not always, congenital, and are generally found in the lower extremities. They have no definite clinical history beyond their gradual and painless increase. My colleague, Mr. Howse, in 1872 excised such a non-encapsuled growth from the biceps muscle of the thigh of a woman æt. 23, which was made up of erectile tissue and highly vascular and had been growing for eight years. He excised all the muscle that was involved, but left its tendon. A good recovery ensued, with free movement of the limb.

Ossification of muscle (myositis ossificans) is a condition which must be recognized. At the College of Surgeons and St. George's Hospital preparations exist which illustrate how the muscles of the back may become plates of bone and the pelvis, ribs, and scapulæ the seat of bony outgrowths. In a smaller way the "drill bone" of the Prussian soldier—a plate of bone in the deltoid muscle—and in this country the "rider's bone," in the origin of the adductor longus muscle of the thigh, are illustrations.

Some years ago one of my colleagues at Guy's excised from the body of the deltoid muscle a piece of bone an inch long, the growth of some years.

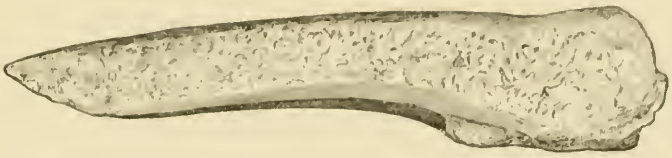
The Rider's Bone.—What has been described as "the rider's bone" is probably at first an inflammatory infiltration, and subsequently an ossification, of the tendon of the pelvic origin of the adductor longus or magnus muscle. I had such a case under observation in the person of a medical friend æt. 44, who while hunting in 1869 made a violent effort to grip his horse when about to make a long jump. The effort was not attended with any pain, but was followed by much ecchymosis, extending down to the knee, and loss of power in the muscles of the part. When these symptoms had subsided, a dense induration was felt in the pubic origin of the right adductor longus muscle, which was painful on manipulation. As time passed this induration not only lasted, but became more dense; and when I first saw him, about three months after the accident, it was clearly in the sheath of the adductor longus and moved with it. It grew somewhat during two years; and when the tendon was rigid it appeared as an outgrowth from the pubis, corresponding to the origin of the adductor longus, of about two inches in length. When the muscle relaxed, it was clearly only in the tendon and had no bony origin. At the present time this gentleman can take his exercise as usual. There is a distinct grating to be heard and felt on moving the tumor, which has not grown for the last three years. The history of the case is identical with that given by Birkett (*Guy's Hosp. Rep.*, 1868). Billroth has also described this affection.

Fig. 461 represents a section of such a bone, kindly given to me by my friend Mr. Gowland, with a microscopical drawing of the same, made by my colleague, Mr. C. J. Symonds.

The bone is irregularly conical in shape and is three inches and a half in length. The base is somewhat flattened and measures three quarters of an inch across.

The section shows an outer layer of compact bone, which, traced toward the bone,

Fig. 461.

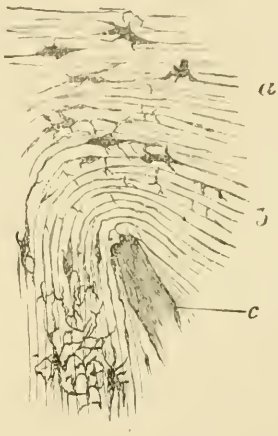


a. Hyaline cartilage.

b. Proliferating cartilage with a matrix staining with eosin.

c. Remains of old matrix of cartilage, with enclosed medulla spaces.

d. New bone developed from the cartilage and arranged in irregular trabeculæ.



a. Lacunæ and canaliculi.

b. Lamellæ.

c. Haversian artery.

Rider's Bone seen in Section, with its Microscopical Appearance.

blends with an irregular bony and cartilaginous mass. Many trabeculæ divide the rest of the surface into a cancellous tissue of rather dense character.

Microscopical sections were made from the base, to show the mode of growth, and on reference to the figure it will be seen that a thick layer (only half is represented in the drawing) of hyaline cartilage forms the surface. This contains more cells than that ordinarily found in normal tissue. The deeper surface shows proliferation of cells and an alteration of the matrix. Irregular cavities result as in normal ossification, though less regularly, and upon the old calcified cartilage the new bone is laid down as in fœtal bone. As in normal ossification also, all the new material takes up the eosin, while the cartilage stains with logwood—a chemical difference apparently the result of growth.

The small figure, sketched from a piece that was ground down in the dry state, shows the lacunæ and canaliculi as in true bone. The lamellæ were irregularly arranged and the canaliculi and lacunæ large, with a less perfect communication than in normal bone (Charters J. Symonds).

Fig. 462.

Cancerous Tumor of the Hand. (Dorsal aspect.)

Tumors of Tendon.

Besides ganglion, other tumors are found connected with tendon, and of these the cartilaginous and fibrous are the most common. I removed from the long extensor tendon of the middle finger of a boy æt. 14 a fine example of the former. Some are said to begin as ganglion, and subsequently to consolidate. I have seen one composed of bone and cartilage of two years' growth, removed from the extensor tendon of the hand, which was said to have such an origin. Tumors with tendons passing through them are not rare, and on two occasions I have had to amputate the hand of a child for a cancerous tumor occupying its palm, through which all the flexor tendons passed (Fig. 462). In 1867 I removed from a boy æt. 3½ a congenital tumor the size of a walnut, which evidently grew from the theca of the tendon of the long extensor muscle of the thumb.

The tendon passed through the tumor which surrounded it. Dr. Moxon examined the growth, which was clearly composed of fat or condensed fibro-cellular tissue, with myself.

The majority of tumors connected with tendons, however, are of the nature of ganglion more or less indurated.

Inflammation of Tendons.

As an acute affection this is most serious and gives rise to severe local and constitutional symptoms. It is met with as a consequence of a severe strain or laceration of tendon, or of some punctured or other wound involving the sheath. It may begin in one toe or finger and spread upward to the palm, and so on to other tendons, and even up the fore-arm. The local symptoms are pain, with the external evidences of inflammation, heat, redness, and swelling, the swelling being deep-seated, while the pain soon extends up the arm beyond the seat of mischief. The constitutional symptoms are those of more or less severe pyrexia.

If surgical interference is not brought to bear upon the case at an early period, suppuration must soon appear, with symptoms of throbbing and aggravated local distress, as well as the constitutional symptoms, rigors, excitement, and depression; inflammation of the absorbents and their glands will probably complicate the case.

Under still more neglect sloughing of the affected tendons and diffused inflammation, with suppuration of all the parts involved in the disease, will ensue. A finger, hand, or fore-arm may be jeopardized or sacrificed if the inflammation be very active or the treatment with which it is met insufficient.

Absorbent inflammation and blood poisoning (septicæmia) are common accompaniments of this affection.

Treatment.—This affection is very amenable to surgical control, and a free incision into the swollen part is the best means of arresting its progress by relieving tension. The operation not only relieves pain, which is caused by the tension of the fibrous tissues from the effusion beneath, but arrests the progress of the affection by preventing the inflammatory effusion burrowing up the theca of the tendon.

For these objects a clean cut down to the theca should be made as soon as hardness of the parts, with external evidence of inflammation, appears. If pus escape, the practice must be good; but if serum only, the operation will tend to arrest the progress of the affection at its onset, prevent the formation of pus, and probably check the disease. The incision should be *vertical* over the middle line of the finger and the centre of the tendon, no vessel or nerve of importance being there in the way.

When suppuration exists, the surgeon must follow up with his lancet every line of inflammation and suppuration; for in no tissue does more harm ensue from retained fluids than in the fibrous.

In the very earliest stage of the inflammation warm fomentations, and possibly leeching, may be beneficial. Elevation of the limb, the hand being higher than the elbow and the elbow than the shoulder, undoubtedly relieves pain. A saline purgative is often serviceable. But the surgeon must not lose time by such temporizing means, for tension of the part means its death by strangulation if not mechanically relieved, and medicines have no material influence upon the affection. When suppuration appears, tonics and liberal diet are required, as well as stimulants carefully adjusted to the necessities of the case. Sedatives are always wanted in some one of their forms. Morphia acts the most rapidly in quarter- or half-grain doses given subcutaneously. Water dressing or poultices should be applied. In very severe cases, when the powers of life are failing, amputation may be justifiable, more particularly when the prospects are small of giving a useful hand or arm. For the arrest of diffused inflammation in the hand and arm the occlusion of the main artery of the limb has been suggested. Moore and Maunder have both adopted it in the upper extremity, with enough success to justify the practice. Bleeding is apt to take place at times during the progress of the sloughing of the tendon; and if recurrent, such a complication is likely to induce the surgeon to perform some operative act for its control upon the main vessel of the extremity. Before doing this, however, he should always remove any sloughing tendon, as I have known hemorrhage, even of a severe kind, to be kept up by the presence of a sloughing tendon in a part, and to have been arrested by its removal.

Chronic Inflammation of Tendons.

The theca of the tendons of the extensors of the thumb, of the tendo Achillis, and the long tendon of the biceps, as of other muscles, are liable to inflame; and this action is attended by pain and weakness on moving the muscles, and at times by swelling. More frequently, however, the affection will show itself by a peculiar crackling sensation, which may be felt on grasping the part when the muscles are in motion. This crepitation, when it has followed an injury, has more than once been mistaken for that of fracture; yet it is distinct, and when once felt ought to be recognized. The affection is readily cured by rest of the affected muscles through the application of splints, and by counter-irritation by means of one or more blisters. The inflammation rarely goes on to suppuration unless neglected.

AFFECTIONS OF BURSÆ MUCOSÆ, SYNOVIAL CYSTS, GANGLION, ETC.

Simple bursæ are protective synovial sacs found in the subcutaneous tissue wherever pressure or friction is persistently present.

Synovial bursæ are of the same kind, and are formed in the same way, although situated between bone and muscle, tendon and bone, or between muscles, while some synovial bursæ are really *synovial hernia*, or pouchings of an overdistended membrane of a joint into the connective tissue between the muscles. A *ganglion* is a bursal swelling directly connected with the sheath of a tendon; it may either involve one tendon and be *local*, or many and be *diffused*.

When a bursa (simple or synovial) has an established anatomical position, it is called normal; and when it is a purely pathological production, accidental. Any of these bursæ are liable to inflame, suppurate, or consolidate.

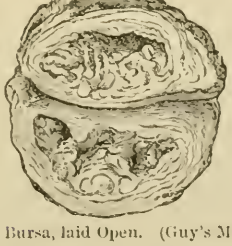
Simple Bursæ.

The subcutaneous bursa over the patella or its ligament is more commonly enlarged than any other, and when it is so is known as the "housemaid's knee." When it acutely inflames, suppuration rapidly takes place; and if an external outlet for the pus is not soon established, diffused suppuration around the knee and over the patella follows. Indeed, most of the cases of diffused suppuration around the knee have their origin in "bursitis."

When the inflammation is less acute and shows itself by serous effusion into the bursa, it may give rise to local pain on pressure and a peculiar crepitation, this crepitation often existing before any perceptible enlargement of the bursa has taken place.

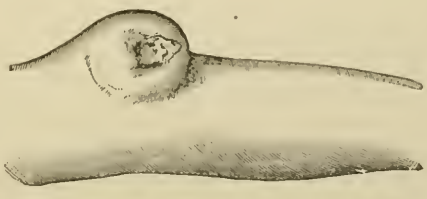
In the more advanced stage, when the effusion has increased, an encysted fluctuating swelling will have formed, which may be tense or flaccid, the degree of tension of the bursa turning entirely upon the rapidity of the effusion. In more chronic examples the bursa will appear harder, firmer, and less distinctly fluctuating, while in very neglected or chronic cases it may have so consolidated as to appear as a solid tumor, although the tumor will contain on section some cavity in its centre, the mass appearing to be made up of concentric laminæ of organized lymph (Fig. 463). In exceptional cases, however, the

Fig. 463.



Semi-solid Bursa, laid Open. (Guy's Museum.)

Fig. 464.



Bursa sloughing from over Patella.

bursa may have completely consolidated. These bursæ, as a rule, contain simple serum, although at times the serum is blood-stained, while in other cases rice-like bodies (organized fibrin) or pedunculated fringe-like outgrowths like loose cartilages exist. When

injured, these bursæ may become filled with blood, their contents being grumous or like coffee-grounds (hæmatocele). Bands of lymph cross the sac at times, but more frequently they line it in regular, onion-like layers. In neglected cases this fibrin may die and slough away, the bursa being cast out as a whole, as in an ordinary cellular membranous ulcer and in the case from which Fig. 464 was taken. In syphilitic subjects this result is not unfrequent.

On the other hand, a bursa may increase by effusion, and by some external cause rupture subcutaneously or externally, and thereby undergo a cure. In 1870 I had a case of the former kind under my care in a man æt. 60 who had a bursa the size of a fist over his patella, which ruptured on kneeling. When I saw him, the cellular tissue about the knee was infiltrated with serum, which was subsequently absorbed, and the bursa did not reappear.

What has been described as taking place in the bursa over the patella may occur in other parts, and more particularly over the olecranon process, where an enlargement of the bursa goes by the name of the "miner's elbow." I have, however, seen them over the acromion process in men who carry timber; over the tendon of the extensor quadriceps muscle of the thigh in a woman who habitually started her sewing machine with the knee; over the tuberosity of the ischium in Spitalfields weavers ("weaver's bottom") and in Thames lightermen; over the dorsum of the foot in extreme cases of talipes equino-varus when the children walked upon the part; over the external malleolus in tailors; over the malleoli, and also the instep, from the pressure of a boot; over the great trochanter of the femur in a soldier, from pressure caused by sleeping on a board; and last, but not least, over the ball of the great toe in cases of "bunion," and in the sole of the foot over the heads of the metatarsal bones in men who walk much with short shoes, or with some who have contraction of the extensor tendons of the toes.

Bursæ will, however, enlarge or form wherever there is pressure, the enlargement being in a measure compensatory to save deep tissues. Yet this rule does not hold good always, for I have seen more than one instance in which enlarged bursæ existed over the knuckles of the first phalangeal joint of the hands without any such cause.

Treatment.—In the early crepitating stage of effusion the removal of all pressure and the application of a blister are, probably, sufficient to effect a cure, and in more advanced stages the repeated application of blisters is often sufficient to excite absorption of the effused fluid and recovery. When these means fail and the walls of the bursa are thin, the cavity may be tapped and the parietes of the cyst firmly pressed together by means of a pad and strapping. When the walls are indurated, this treatment is useless; but a cure may generally be effected by the introduction of a seton, which should be kept in till suppuration is freely established. In more solid cysts none of these means are of use and excision is the only sound practice, the surgeon making his incision over the outer border of the bursa in order that the cicatrix may be out of harm's way. In some few instances where tapping has proved ineffectual, the cyst may be injected with thirty or more drops of the compound tincture of iodine in a drachm of water, as in hydrocele. When blood has been effused into the bursa from a blow, as indicated by its sudden increase, a free incision into the cyst and the evacuation of the clots may be expected to be followed by a recovery; but this should be done only when its absorption does not take place by natural processes. When loose or pedunculated bodies exist in a bursa and cause distress, they may be removed by means of a free incision through its walls.

Synovial Bursæ.

An enlargement of a synovial bursa is a far more serious affection than that which has been just described, as these bursæ are situated about tendons or muscles, the articular extremities of bones and joints, and in many instances, indeed, have direct communication with joints.

There is a deep bursa beneath the deltoid muscle which when inflamed gives rise to swelling around the shoulder-joint and pain and crepitation on movement, simulating shoulder-joint mischief; at times, too, this bursa communicates with the joint through the bicipital groove in which the biceps tendon plays. It may be distended with serous fluid or may contain loose bodies such as are found in other bursæ or ganglia. They should be dealt with cautiously, on account of the possibility of their communicating with the joint. Hence, blistering and absolute rest of the arm are the best means to employ, the bursæ being opened only when obstinate and when pouching exists in front of the deltoid tendon. From one of these bursæ, on two occasions, I have evacuated within

three months more than half a pint of bursal fluid, containing melon-seed-like bodies, a recovery subsequently taking place. Such an operation should, however, be done only after grave consideration.

Another extensive bursa, situated beneath **the extensor muscles of the thigh**, is not infrequently the seat of acute or subacute inflammation; and such cases have been mistaken for inflammation of the knee-joint. The diagnosis ought not, however, to be difficult, for in the bursal enlargement, however great, the bulging of the cavity will seldom extend downward beyond the upper border of the patella, and will not, as in joint disease, extend to either side of that bone or below it. Fluctuation, moreover, will be felt only above the joint, and not obliquely through it. When the patient stands, the difference between the distension of the bursal and that of the synovial sac will be also at once manifested. With this enlargement there may be some stiffness of the joint, but there will always be mobility. This bursa at times becomes the seat of suppuration, when the necessity of a correct diagnosis is more important on account of treatment. In all cases it is necessary to maintain rest, and the absorption of the fluid should be promoted by blisters. In obstinate cases, when the bursa is very tense, the cavity may be tapped, and when it suppurates freely opened; but neither of these operations should be undertaken without strong necessity. Suppurative inflammation of the bursa may extend to the joint with a fatal result. I have tapped such a bursa in a woman æt. 35 and drawn off eight ounces of a thick, grumous-looking, semi-purulent fluid with success; in a second case, a woman æt. 50, I made a free incision into the bursa and evacuated many ounces of pus and blood such as escapes from a hæmatocele; a good recovery took place.

The deep bursa between **the ligamentum patellæ and the bone** is very liable to inflame and enlarge, which gives rise to pain that is often mistaken for joint disease. The pain, however, is always local over the bursa and aggravated by the patient attempting to raise the extended leg. It is very troublesome, and when established can be treated successfully only by means of blisters and rest with the leg on a posterior splint.

The bursa situated over **the upper part of the tuberosity of the os calcis**, between the bone and the tendo Achillis, is sometimes inflamed, and gives rise to a marked projection in the part; it causes pain and lameness. It is to be cured by absolute rest (the foot and leg being fixed on a splint) and the application of blisters.

A bursa also naturally exists in connection with and beneath **the tendon of the psoas muscle** as it passes over the arch of the pelvis; this may also communicate with the hip-joint. When distended with fluid, it will give rise to a swelling in the upper part of the thigh on the inner side of the femoral vessels, which will be soft and fluctuating, but will not receive any impulse on coughing, like a psoas abscess, for which it is apt to be mistaken.

The bursa between **the tendon of the gluteus maximus and trochanter** may also inflame and suppurate; and when it does, it gives rise to a troublesome, and often dangerous, affection. When suppuration takes place, an opening may be made, which should be free, but the thigh must be well fixed. When suppuration does not occur naturally, the surgeon should be in no hurry to open the bursa, but be satisfied to keep the limb at rest and blister the swelling.

Synovial bursæ in the popliteal space require a rather longer notice than the forms to which attention has already been directed, since they are, although common, sometimes difficult to diagnose and dangerous to treat. Their treatment, however, as a rule, is successful.

These bursæ may be divided, in a clinical point of view, into two classes, the *first* including such as are connected with the sheaths of tendons or that encircle their insertion, and have no communication with the knee-joint; the *second*, those that directly or indirectly communicate with the joint and are either synovial herniæ pouching from it or bursæ originating about the tendons and communicating with it.

Among the *first* is the normal bursa which exists above the head of the fibula on the outer border of the popliteal space between the insertion of the biceps muscle and the external lateral ligament; a *second*, which may be said to be on the outer border, although it has a somewhat more central position, which separates the external lateral ligament from the tendon of the popliteus muscle; and a *third* on the *inner* side of the space which lies between the tendon of the semi-membranosus muscle and the inner tuberosity of the tibia, the whole of these bursæ occupying the *lower* half of the popliteal space.

In the *second* division there is the smaller bursa which separates the outer head of the gastrocnemius muscle from the outer condyle of the femur, and the larger that normally exists between the internal condyle of the femur and the inner head of the gastrocnemius

and semi-membranosus muscles, and which generally sends a process between these muscles, the smaller occasionally, and the larger generally, communicating with the knee-joint, both of these occupying the *upper* half of the popliteal space.

The larger bursa may have its origin on the inner side of the popliteal space, but as it grows invariably encroaches on it and becomes central, and is more frequently enlarged than any of the other popliteal bursæ.

All these normal synovial bursæ may become enlarged under the influence of over- or prolonged exertion or any sudden strain, the smaller ones increasing to the size of a walnut and the larger to that of an orange. As they increase so they become central, and as they assume a central position difficulties in their diagnosis may be experienced. They may contain a thin, clear, or blood-stained serous fluid, a tenacious, synovial, or colloidal, apple-jelly-like material, and, in exceptional instances may have consolidated. I have, however, known this to occur but once. It is probable that the bursæ which have serous contents do not communicate with a joint, while those that have synovia do.

Diagnosis.—In a general way, there ought not to be any difficulty in making these cases out, more particularly when the different positions in which they may appear are known, since their circumscribed and defined outline, their fluctuating feel and mobility when the leg is flexed, and their hardness and elasticity when fully stretched, fairly characterize them. When, however, the swelling pulsates and a bruit is heard over the tumor, some difficulty in diagnosis may be felt, although I can hardly understand how such a case could be mistaken for an aneurism, as on a careful examination the bursal pulsatile swelling could not be emptied and refilled by the application and removal of pressure upon the afferent artery, as would an aneurism; neither would the pulsation be so distinct nor the bruit so clear, for both the pulsation and the bruit would have been simply communicated. The position of the bruit, moreover, would have a greater influence upon the symptoms in a case of bursa than in that of aneurism; for whereas, in the latter, by *slightly* flexing the leg upon the thigh, the aneurism would become more defined, its pulsations more marked and under control, in bursæ the swelling would become more flaccid and less distinct. Extension makes the pulsation and the swelling more distinct in the case of bursæ, and less so in that of aneurism.

With respect to the diagnosis of a synovial bursa which communicates with the knee and a true synovial hernia, I have not much to add beyond the fact that in the former there may be no symptons of knee-joint disease, whereas in the latter there will to a certainty be chronic effusion into the joint, which probably will be part of an osteo-arthritic change.

When pressure upon the popliteal swelling causes it to diminish or disappear, while the joint itself enlarges and becomes fluctuant, or more so under the pressure, it is a fair inference that the joint and bursa communicate; although, when these conditions do not exist, it would be wrong to infer the opposite, for the opening from a bursa is at times valvular and altered by position.

Treatment.—As an enlargement of these bursæ always follows excessive muscular action and strains, so by absolute rest of the limb, as guaranteed by a splint and the application of repeated blisters, can the bulk of them be made to disappear. In obstinate examples of the first division of cases tapping may be resorted to; whereas in the second it should be undertaken only where other treatment has failed, and then with extreme care by means of the aspirator. In still more obstinate cases, where the limb is rendered useless, a free incision may be made into the cysts or they may be excised; but such desperate measures are applicable only in desperate cases.

The first division of cases may always be boldly dealt with, but the second should be treated with extreme caution.

Thus, in a case which was under my care some years ago, where by repeated blistering the tumor disappeared for a time only to recur, a surgeon was induced to tap, and subsequently incise, the cyst; after which acute suppuration of the part occurred, which in the end compelled amputation.

The case of solid bursa already alluded to occurred in my own practice. I mistook it for a tumor, having punctured it with a needle without obtaining any flow of fluid. It was in a man of middle age, had been growing for about ten years, was the size of a fist, filled the popliteal space, and was solid and movable. I found that it was connected with the inner hamstring tendon only when making the attempt to remove it. On recognizing its nature I took away a large portion of the mass down to its central cavity, which was the size of a nut, but I left the deeper part. Suppuration, however, subsequently attacked the knee-joint, and amputation became necessary. I am unable to point

out how a correct diagnosis could be made in such a case as this, but the record of the fact that a solid bursa may exist in this locality, as well as the unfortunate result which accrued upon operation in my case, may be of value. Holmes draws attention to a valuable paper by M. Foucher on this subject in the *Archives Générales de Méd.* (1856).

Synovial Cysts.

In connection with this subject of synovial hernia it should be stated that at times these herniæ rupture and the synovial fluid escapes into the connective tissue of the leg, forming a synovial cyst; and if Mr. Wormald was right when he taught that the thinnest point of the joint capsule was at the spot at which it partially encircles the tendon of the popliteus muscle, it is more than probable that it is at this spot that the fluid escapes.

The synovial cyst may occupy the popliteal space and upper part of the calf of the leg or may be evident in the calf of the leg only, projecting most, as a rule, on the inner aspect of the leg, or may be perceptible only at the upper and inner part of the leg as a small defined swelling, not approaching within three or four inches of any part of the knee-joint. There need not of necessity be any communicable fluctuation between the cyst and the joint.

These cysts are generally found in joints that are the seats of osteo-arthritis, and are curable. They should not be punctured or otherwise subjected to operation unless there appear strong reasons for so doing, inasmuch as interference may lead to acute inflammation and suppuration of the knee-joint.

For this information I have to thank Mr. Morrant Baker, who has written a valuable paper on the subject in the *St. Bartholomew's Hosp. Rep.* (1877). It recalled to my recollection several cases which were doubtless of this affection, and which I did not understand.

Ganglion.

This is met with in two forms—the one the more common as an encysted swelling connected with the sheath of a tendon; the second as a more diffused swelling involving the theca of one or of many tendons, those of the wrist being the most commonly affected and the flexors more frequently than the extensors. I have, however, seen it in the extensors of the toes and on the dorsal aspect of the foot beneath the annular ligament of the ankle, but it may attack any tendon. Ganglion is always the result of strain or overaction of the tendons. The local ganglion always contains colloidal apple-jelly-like material, which is at times crystal-like in clearness, at others pinkish. In the diffused the fluid is more like synovia, containing loose bodies.

"The bursæ or ganglions which form about the sheaths of the tendons at the wrist appear to be the cystic transformations of the cells enclosed in the fringe-like processes of the synovial membrane of the sheaths. . . . . Sometimes they are distended with serous fluid; at other times their contents possess a gelatinous, or even a honey-like, consistency, which constitute a form of meliceris. Under some circumstances free fibro-cartilaginous-like bodies, irregularly shaped, composed of a compact connective substance, form in considerable numbers, more especially in the ganglionic enlargement of the synovial bursa which surrounds the flexor tendons of the fingers at the wrist" (Paget, *Surg. Path*).

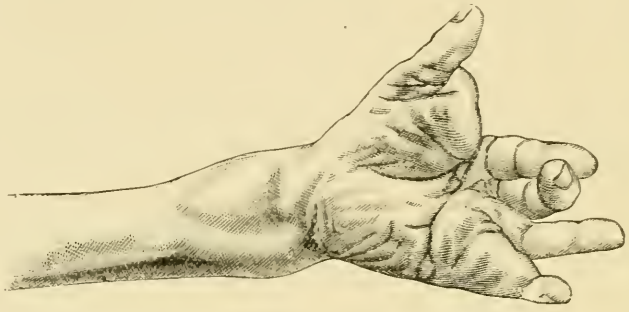
The **localized form** of ganglion is more common on the dorsal aspect of the wrist than anywhere else, although not rarely it is connected with the flexor tendons and appears as a globular or irregularly cystic, tense swelling of the part. At times it is very hard, at others fluctuating and soft. When of good size, it may be translucent. Pressure upon it to any extent causes pain; severe pressure, sickening pain—even fainting and vomiting. Those in the palm of the hand about the head of the metacarpal bones are the most painful. At times ganglion is painless, causing only some weakness of the wrist.

A large ganglion occasionally forms behind the external malleolus connected with the peronei tendons. It should be touched with care.

The **diffused or compound ganglion** varies in its symptoms according to the number of tendons involved. When one only is affected, it may appear as a deep-seated, fluctuating, irregular swelling in the course of the tendon, the amount of swelling and deformity depending entirely upon its size. The swelling, when many tendons are involved, will be diffused; but when the whole of the flexor tendons are implicated, it

will occupy both the palm of the hand and the fore-arm above the wrist. In the case illustrated in Fig. 465, taken from a woman æt. 49. sent to me by Dr. Lovegrove, now of Hythe, all the flexor tendons were involved to an extreme degree. In such cases as these the foreign bodies commonly called "melon-seed or rice-like" bodies are usually present. They may frequently be made out to exist by the surgeon when ascertaining the presence of fluctuation from above and below the annular ligament of the wrist by firm pressure alternately applied in this direction, the pressure exciting a peculiar rough scrooping sensation, caused by these loose bodies passing along the thecæ of the tendons beneath the ligament.

Fig. 465.



Ganglion involving all the Flexor Tendons of Hand and Wrist.

Treatment.—The local ganglion, when first formed, may often be cured by the application of a blister and by securing rest to the tendon by means of some splint: but when it has existed for some time, such treatment is useless. When it can be ruptured by pressure applied by grasping the flexed hand with both hands and by one thumb superposed upon the other over the ganglion, a cure may often be effected, firm pressure being subsequently kept up by means of a pad of lint and strapping. When this fails, the ganglion should be punctured subcutaneously by means of a spear-shaped needle or fine tenotomy knife, its contents squeezed out, and pressure applied by lint and strapping as before. When success does not follow this treatment, a silk seton may be introduced, the hand being kept quiet on a splint, but it should be removed so soon as suppuration has been established. This treatment should not be employed, however, until all minor means have failed; for it is occasionally followed by diffused inflammation of the theca of the tendon with all its dangers.

The diffused or compound ganglion is dangerous to deal with—that is, any interference with it may be followed by severe inflammation of all thecæ involved, and thus limb and life be jeopardized. But this result is not common when proper precautions are taken to guard against it. The risk of such a thing should always, however, be laid before the patient by the surgeon before any operation is arranged.

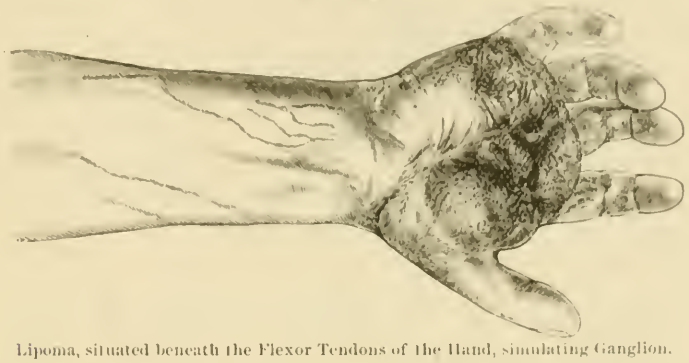
The only effectual way of dealing with it is by incision. To do this the surgeon should for some five or six days before fix the hand and fore-arm upon a splint; he should then make a clean cut into the affected theca, free enough to allow of the ready escape of all the ganglion contents without any forcible manipulation. When many thecæ are involved, more incisions than one are called for. The incision should always be made in a vertical direction over the tendons, and both above and below the annular ligament when the disease extends up the arm. After the operation the whole cavity should be well washed out with iodine water and the wound dressed with terebene oil or iodoform gauze and powder. A splint should be kept on for a week, after which movement of the finger should be allowed when the fear of diffused suppurative inflammation has passed away. In the severe example of the affection illustrated in Fig. 465 this practice was adopted with success, and in many others of a less severe character I could record the same result. I have never had occasion to divide the annular ligament as advised by Syme in the *Edinburgh Monthly Journ.* (October, 1844).

The case illustrated in Fig. 466 was mistaken for this affection; it occurred in a man æt. 49, and had been of many years' duration. The swelling had the appearance and feel of the diffused ganglion with foreign bodies. Indeed, the sensation of the presence of foreign bodies was marked between the dorsal and palmar surface of the hand. The swelling was, however, entirely confined to the hand and did not extend upward above

the annular ligament (*Lancet*, 1884, p. 846). My friend Mr. H. Morris tells me that he has seen two cases of fatty tumor connected with the median nerve with clinical symptoms like those described.

I operated upon it as for ganglion, and to my surprise found the whole swelling was due to the presence of a diffused lipomatous tumor situated beneath the deep flexor ten-

FIG. 466.



Lipoma, situated beneath the Flexor Tendons of the Hand, simulating Ganglion.

dons and completely surrounding them, dipping down between the bones to appear upon their dorsal region. I removed the mass with much difficulty after a tedious dissection, washed the whole palm out with iodine water, and puffed into the wounds some powdered iodoform. I then fixed the hand upon a dorsal splint. Quick repair followed the operation without constitutional disturbance or suppuration. Within three weeks the man was well, and returned home with a hand in no way impaired by the severe operation it had been subjected to. In this case the fact that the swelling had not extended above the annular ligament ought to have suggested that another cause than ganglion existed to explain the symptoms.

CHAPTER XXIX.

DEFORMITIES, CLUB-FOOT, AND ORTHOPÆDIC SURGERY.

MALFORMATIONS.

MALFORMATIONS remain to be considered, those of special parts having already received attention under other headings.

They may roughly be classed as being due either to *excess*, or hypertrophy, or to *deficiency*.

Unnatural adhesions between parts is not rare, and maldevelopment in some odd way is occasionally met with.

As examples of excess of development supernumerary fingers or toes are the most common, the supernumerary digits being more or less well formed or rudimentary, either appearing as skin appendages (8, 9. Fig. 467) or being more like cleft phalanges with common metacarpal or metatarsal bones (2, 6, 7, Fig. 467). The thumb is very commonly cleft.

Thus, out of 20 cases of supernumerary fingers and toes consecutively noted, 8 were of the thumb and 4 of the fingers alone, 3 of the toes alone and 5 of the fingers and toes together, the deformity being symmetrical in 6 of the cases. Occasionally supernumerary fingers or toes have perfect metatarsal or metacarpal bones, and more rarely the hand may be double. The late Jardine Murray of Brighton has recorded such a case (*Med.-Chir. Trans.*, vol. xlvi.).

Hypertrophy of extremities is met with, either of whole limbs or of parts of limbs. In drawing 10, Fig. 467, hypertrophy of one finger is shown associated with deficiency of others, but hypertrophy is a type of the affection that is met with in practice, whether of a digit or of an extremity.

Treatment.—Rudimentary fingers and toes may be fearlessly excised when they appear as skin appendages; but when they exist as bifid phalanges, great care is called for in their treatment, on account of the frequency of there being a common joint to the two digits. Under these circumstances the surgeon should carefully consider the ques-

Fig. 467.

Types of Different Kinds of Deformities of the Hands and Feet, with a Drawing of a Child with a Caudal Appendage. (Taken from life.)

tion of amputation; and if he decide upon performing it, it will be wise to cut off the supernumerary digit some little distance from the joint, leaving a stump, which, as a rule, subsequently withers.

Hypertrophied extremities may be removed when they are sources of great inconvenience, but not otherwise.

Webbed fingers and toes are another common deformity. At times all the digits of one or both hands or feet are webbed, but more commonly only two are involved. Thus, I have seen the thumb and index finger webbed in one case (No. 3, Fig. 467), the ring and middle fingers of both hands in another (No. 4), and again, in another, the second and third toes of both feet. In one instance the toes of one foot were webbed and the fingers of the hands more or less truncated. In another, with webbed toes on both feet, there was a supernumerary right thumb. Indeed, where a disposition to deformities shows itself, several varieties of deformity may coexist in the same subject.

Treatment.—For the hand, when the fingers are well formed, the surgeon, if possible, should divide the web, but under other circumstances it is more prudent to leave it alone. When the web is very narrow, there is nothing left but to divide it; but before doing so a good opening at the base of the cleft ought to be established, to prevent the subsequent closure of the wound. This can be efficiently effected by means of the galvanic cautery or otherwise and the subsequent introduction into the opening of a piece of aluminium wire, the wire being kept in till the wound has cicatrized and become as thoroughly established as an ear-ring hole. When this step of the operation has been effected, the cleft may be fearlessly divided.

When the web is broader and more material exists for the surgeon's manipulation, the best plan to adopt is to split the web transversely between the fingers and to turn one flap

of skin round one finger and the other flap round the second, stitching the edges of the flap to the skin of the finger.

Webbed toes need no surgical interference.

Absence of parts cannot surgically be remedied. In No. 13, Fig. 167, there was an absence of a thumb, but by way of compensation an extra finger was given. In No. 14 the ring finger was absent, but the index and middle fingers were hypertrophied.

At other times limbs are truncated as if from intra-uterine amputation, and in rarer cases bones and joints seem to be deficient. Thus, in a male subject I had under care some years ago the right arm was shortened, as if amputated above the elbow, and the right lower extremity was represented by one short bone, with a foot that would have been called perfect if the little toe had not been absent.

These cases are mentioned, however, only as curiosities, and are beyond the pale of the surgeon's art.

Claw-like extremities, as represented in Nos. 1, 11, and 12, Fig. 167, are very curious. No. 1 represents the hands of George N——, æt. 7 weeks, the third child of well-made parents, the other children being natural. Very little power existed in the claws, one finger alone being of use. The child in other respects was well made and intelligent.

Nos. 11 and 12 were taken from Edward E——, æt. 4, one of eight children, three being boys and five girls, one brother having precisely the same deformity. The parents were well made.

The hands in No. 11 had apparently but three metacarpal bones, the wrist and carpal joints being normal; the solitary digit had much power. The feet in No. 12 were still more oddly made. In both the tarsal bones seemed to be natural, but on the right foot the metatarsal bones were confused together. The digits had good power. Nothing could be suggested for the patient's benefit.

Hereditary Nature of Deformities.—The hereditary nature of deformities is generally recognized, though in the history of such cases it is exceptional for such a tendency to be traced. When, however, it is made out, it is, as a rule, remarkable. Deformities, when inherited, are also generally of a like kind. Thus, deformities of the genital organs are passed on to succeeding generations, as is the disposition to harelip or webbed fingers, etc.

Exceptions to this rule are met with. Thus, in a family of twelve children, two out of four boys had harelip and fissured palate, and one out of eight girls had hypertrophy of the right lower extremity, with atrophy of the right great toe. The father of this family had a supernumerary little finger on one hand.

A female child, one of five, the other four being well made, had hypertrophy of the two inner toes of the left foot. They were at five weeks old as large as the toes of an adult and as well made. The parents had no deformity, but the father's maternal grandfather had a double thumb.

A boy had a double thumb on one hand and a web between the second and third toes of both feet. His father had webbed toes.

These exceptions to the rule above given are, however, rare.

As illustrations of the rule the following cases have been extracted from my note-books.

A man had six perfect toes on each foot and six perfect fingers on each hand. He was one of ten children, all of whom had the same kind of deformity. The parents of these children were, however, well made.

A female child had left equino-varus. She was one of eight children, the other seven being well made. The parents had no such deformity, but the mother had two brothers and one sister so deformed, and her father had double talipes.

A man had scrotal hypospadiasis and was one of nine children. Both his parents were well formed and no history of deformity could be traced backward. One of his sisters had harelip, while two of his brothers were deformed as he was, one having passed as a female till he was eighteen years of age. Two other brothers and three sisters were natural, but each of these brothers had a son a hypospadiac.

These cases are very striking.

Club-Foot.

When paralysis takes place of a single muscle or of a group of muscles functionally associated, the opposing muscle or group, losing antagonism, acts uncontrolled, and, as a

consequence, contraction or deformity is liable to be produced, the deformities resulting from this class of cases being designated *paralytic distortions.*

When a muscle or a group of muscles, from whatever cause, acts spasmodically with an active tonic contraction or a slow and progressive one, quite irrespective of the will or but slightly influenced by it, and in this way overcomes the opposing muscle or group of muscles, deformities may likewise be produced, such cases being called *spastic* or *spasmodic distortions.*

In the first class the degree of deformity depends much upon the degree of paralysis present, and in the second on the amount of spasm or contracting force of the muscles involved. Some surgeons would class all deformities in the first group, but this view is incorrect.

Both may be *congenital* or *acquired.* In the congenital greater changes take place in the conformation of the bones than in the acquired, these changes depending much upon the intensity of the muscular action, but more upon the period of life at which they commenced.

"It seems as if in congenital club-foot and analogous distortions a stimulus or irritant were present in the medulla spinalis, acting upon certain ganglionic cells there, which keeps the affected muscle in a state of chronic contraction, yet not sufficient to neutralize the stimulus of the will within the limits of movement permitted by the structural shortening of the member. Many non-congenital spastic contractions appear allied to the condition which prevails in some states of chorea, in which, when the will would permit or cause contraction or relaxation of a particular muscle, an involuntary influence excites contraction, interferes with and frustrates the voluntary effort. In more intense spasmodic contractions the will is entirely overpowered before structural shortening supervenes to effect the same end" (Little).

As an extra argument in favor of this view the fact may be adduced that club-foot often coexists with other deformities, such as spina bifida and club-hand, etc. "Congenital and non-congenital club-foot spring from analogous causes."

When these muscular contractions are powerful enough or continue long enough to alter the natural position of a part, deformity is said to exist, and according to its seat or form a special name is given to it.

To Stromeyer abroad, as well as to Little in this country, we are chiefly indebted for most of our knowledge on this matter, although in more recent times Tamplin, Lonsdale, W. Adams, Brodhurst, and others have added much to the subject.

Stromeyer, however, in 1831, only followed Delpech in 1828, this great surgeon following a greater—John Hunter, who in 1794 established the principle of subcutaneous surgery when he divided injuries to sound parts into two divisions and established this principle—that "the injuries of the first division, in which the parts do not communicate externally, seldom inflame, while those of the second commonly both inflame and suppurate."

Club-foot may be divided into four typical forms:

Talipes equinus, in which the heel is simply draw up by the contraction of the muscles of the calf (Fig. 468); **talipes varus,** in which the foot is drawn inward to

FIG. 468.

Talipes Equinus.

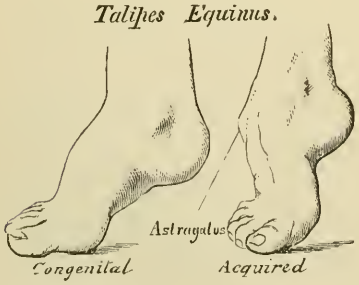


FIG. 469.

Congenital Varus.

Three Grades of Severity.

different degrees (Fig. 469); **talipes valgus,** in which the foot is turned out (Fig. 471); and **talipes calcaneus,** in which the foot is drawn up and the heel depressed (Fig. 472).

Combinations of these forms are commonly seen. Thus, we have *T. equino-varus,* when the foot is turned *in* and heel drawn up (Fig. 470); *T. equino-valgus,* when the foot

is turned *out* and the heel drawn up, *T. calcaneo-varus* and *calcaneo-valgus* being terms applied when the heel is depressed and the foot turned in or out.

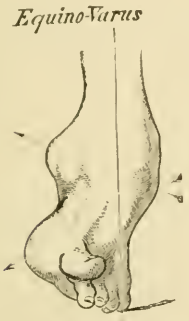
Talipes varus is the usual congenital form, but any may exist, talipes equinus and equino-varus and valgus being the more common acquired forms.

In *valgus* the peronei muscles are chiefly involved; in *varus*, the adductors, particularly the two tibials; in *equinus* there is contraction of the muscles of the calf through the tendo Achillis; and in *calcaneus*, paralysis of the same group.

Club-foot is often hereditary and more prone to attack the male branches of a family than the female, and in this respect it seems to follow the ordinary law of all deformities. In a case under my care of talipes varus the child's father, grandfather, and great-grandfather on the father's side had congenital talipes, while none of the female branches of the respective families were deformed.

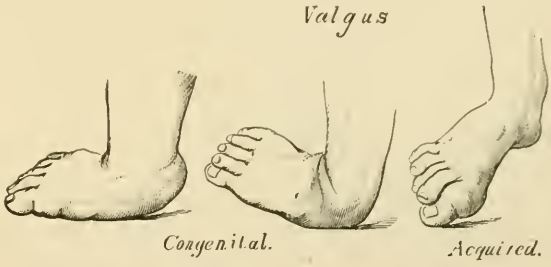
"It is convenient, for practical purposes, to divide congenital club-foot into three degrees of severity: the *slightest*, that in which the position of the front of the foot, when inverted, is such that the angle formed by it with the inside of the leg is greater than a right angle, and in which the contraction is so moderate that the toes can easily be brought temporarily by the hand of the surgeon into a straight line with the leg and the heel be depressed to a natural position. The *second* class includes those in which the inversion

Fig. 470.



From Little.

Fig. 471.



of the foot and elevation of the heel appear the same or little greater than in those of the first class, but in which no reasonable effort of the surgeon's hand will temporarily extinguish the contraction and deformity. The *third* class comprises those in which the contraction of the soft parts and displacement of the hard parts reaches the highest degree, so that the inner margin of the foot is situated at an acute angle with the inside of the leg, sometimes, or even almost in contact with it. Cases of the first and second grades may be respectively converted into the second and third grades by delay in the application of remedies and by the effects of improper locomotion" (Little).

Talipes *equinus* is the most common form of the acquired talipes, although Little positively declares it is at times congenital. It is found in every degree, from the inability to flex the foot beyond a right angle to a pointing of the toes, necessitating the patient walking upon the heads of the metatarsal bones and phalanges, the head of the astragalus projecting prominently on the dorsum of the foot. Fig. 468 illustrates the medium and extreme forms.

Talipes *varus* is the more common congenital form. Fig. 469 illustrates it in three degrees of severity.

It is very frequently combined with T. equinus, as seen in Fig. 470. The arrows in the figure indicate the direction of the convexity of the tarsus and metatarsus forward and outward; the perpendicular line through the axis of the limb shows the extent of the inward deviation of the metatarsus, by which the base of the little toe, being brought completely beneath the axis, has to support the entire weight of the body in walking.

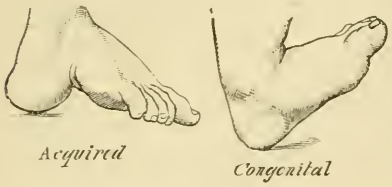
Talipes *valgus* may be of all degrees of severity and may be congenital or acquired, these two varieties presenting very different appearances. Fig 471 illustrates the congenital form in two degrees of severity, and also the acquired.

Talipes calcaneus is illustrated in Fig. 472.

For a full detail of the anatomical changes of the foot under these different conditions, *vide* Adams in *Path. Soc. Trans.*, vol. iii.

Before considering the treatment of these affections it will be well to look into the principle upon which all interference must be based and the process by which repair can take place after the division of tendon.

FIG. 472.



To Paget and W. Adams, in this country, we are chiefly indebted for our knowledge of this subject, and I shall as much as possible use Adams's description of this process, as published in 1860 in his work on the *Reparative Process of Human Tendons after Division*, his investigations having confirmed those of the former, as well as added to our stock of knowledge.

When such a tendon as the tendo Achillis is divided subcutaneously, the divided ends separate, in an infant for half an inch and in an adult from one to two inches, the degree depending much upon the healthy condition of the divided muscle and the amount of movement subsequently permitted in the ankle-joint.

The reparative process begins by increased vascularity in the sheath of the tendon, which is followed by the infiltration of a blastematous material into its meshes, or spaces between its fibrous elements, exhibiting the development of innumerable small nuclei, a few cells of large size and irregular form, with granular contents, or perhaps with one or more nuclei, and studded with minute molecules of oil, a blastematous material, in which the cell forms do not develop beyond the stage of nuclei, appearing to be the proper reparative material from which new tendon is developed. This nucleated blastema soon becomes vascular, capillary vessels having been seen in it on the eighteenth day; the nuclei assume an elongated, spindle, or oat-shaped form, and are seen, after the addition of acetic acid, to be arranged in parallel linear series. The tissue becomes gradually more fibrillated, and at last fibrous, a solid bond of union subsequently forming between the divided extremities of the tendon, which is tough to the touch, but to the eye presents, even for at least three years, a grayish, translucent appearance, distinguishing it at once from the glistening old tendon. This new tissue remains during life as permanent, and has little tendency to contract subsequently. Adams's observations rather led him to the conclusion that the required portion of new tendon is to be obtained during a lengthened period of formation—that is, about two to three weeks, under the ordinary conditions of health; but in paralytic cases, as in others of feeble health, this period may be doubled.

Adams informs us, also, that the divided extremities of the old tendon take no active part in the reparative process during its earlier stages, although at the later the cut ends become rounded and their structure softened. They become enlarged and exhibit a tendency to split, and thin streaks of new material similar to that already described are seen between the fibres; the ends are joined by these means. At a later period the bulbous enlargement gradually diminishes.

When a tendon is divided a second time, there is but little separation of its ends, and this is probably due to adhesion of the new tendon to the neighboring fibro-cellular tissue; in which fact is found an explanation of the unsatisfactory results of second operations.

There is no reason for believing that in the treatment of deformities by tenotomy direct approximation and reunion of the divided extremities of the tendon must first be obtained, and that the required elongation is afterward to be procured by gradual mechanical extension of the new connecting medium, as we would stretch a piece of india-rubber.

Gradual mechanical extension, however, is required in cases of *long standing*, as in those of *congenital* origin, to forcibly overcome ligamentous resistance and to separate the ends of the divided tendons, as it is in those of *paralytic* and *non-congenital* origin to prevent the too rapid separation of the extremities of the tendon. The mechanical extension should be carefully regulated according to the activity of the reparative process, as indicated by the amount of effusion into the sheath. Blood poured out into the sheath, or any inflammatory action, interferes much with the process of repair, any causes of general feebleness, coldness of the limb, too early, too late, or too forcible extension, having a like effect. With these remarks the operation itself may be considered.

TREATMENT.—"The indications," writes Little, "are to overcome the shortening of the muscles, ligaments, fasciæ, and integuments on the *contracted side* of the member, to direct the bones into their proper position, to educate the patient's voluntary use of the

parts, to give strength to the muscles and ligaments in the *elongated* side of the member, to combat the tendency to relapse."

To fulfil the first indications mechanical means are often sufficient; and when these fail or are inapplicable, the division of the contracted structures is required. To carry out the other, mechanical means are also of value, aided by general measures, and more particularly by galvanism of the weakened muscles. In a large number of cases, however, instruments are not needed, much less tenotomy, since in any case of congenital or infantile talipes when the foot can be brought into its normal position with but little force a cure without operation can with some confidence be promised.

In the very simplest cases mere friction of the affected limb and the daily extension of the contracted tendons are often enough to effect a cure, the nurse or parent holding the crooked foot for some ten or fifteen minutes two or three times a day in the required position.

In the next class of cases, which are slightly worse than the last, in which the foot can be brought with gentle force into its natural place, a cure can be effected by means of strapping adjusted in the fashion depicted below (Fig. 473). The strapping must be of a firm nature, that spread on linen being the best, as used at Guy's. The first piece acts as a kind of splint, and the second, on binding down the first to the ankle, admits of any amount of force required to bring the foot in or out, according to the nature of the case. In a still more severe form, where the former method is inapplicable, a small tin splint covered with leather with a screw hinge at the ankle, such as that advised by Little or made for myself by Milikin may be employed, the foot being forcibly brought into the required position and fixed there by strapping. Buchanan's splint, as seen in Fig. 474, is excellent.

Fig. 473.

Mode of Stretching Fool in Talipes Varus by Strapping.

Fig. 474.

Buchanan's Splint for Talipes.

In the worst forms, where by no ordinary force the foot can be brought into the required position, the division of the shortened tendon, tendons, or fascia should be performed, no more structures being divided than is absolutely essential.

"When deciding on the necessity of operation, the surgeon must not be guided solely by the external configuration, but by the amount of firm resistance opposed to restoration, by the depth of the furrows existing in the sole and behind and above the heel, and by the degree of tension of the integuments above the internal malleolus. The deep clefts or furrows in question denote intensity of contraction of muscles and closer adhesion than usual of integuments and fascia to the subjacent soft structures and bones. They probably denote, also, that the deformity dates from an early period of uterine existence" (Little).

Sayre's law upon this point is very good. "Place the part contracted," he writes, "as nearly as possible in its normal position by means of manual tension gradually applied, and then carefully retain it in that position; while the parts are thus placed upon the stretch make additional point-pressure with the end of the finger or thumb upon the parts thus rendered tense; and if such additional pressure produces *reflex contractions*, that tendon, fascia, or muscle must be divided, and the point at which the reflex spasm is excited is the point where the operation should be performed. If, on the contrary, the additional point-pressure does not produce reflex contractions, the deformity can be overcome by means of constant elastic tension; and the more you cut, the greater will be the amount of damage done" (*Orthopædic Surg.*, 1876).

In all cases treatment should be commenced *as soon as possible*, and the foot of the youngest infant may be dealt with advantageously by manual extension a few days after birth. Within a week extension by strapping may be carefully employed, the foot being

looked to daily to see that no sloughing or cutting of the skin by the strapping takes place. In infants the tendons yield far more readily than they do as months or years go on, and with care no harm can accrue from simple mechanical extension. Even splints, carefully applied, can be used.

When tenotomy is clearly a necessity—that is, in grave deformities—there is no reason, in a healthy well-developed babe, why it should not be performed within a month after birth. I have divided the tendo Achillis for a talipes varus with an excellent result at the end of the first week, and Mr. Little has operated successfully within twenty-four hours of the child's birth.

The Operation.

In a large number of cases of congenital varus the division of the tendo Achillis is enough, the foot, after division of the tendon, being generally capable of restoration to the required position by mechanical means, but in severe examples the anterior or posterior tibials, singly or together, may require to be cut. These three tendons may be divided at one operation in average cases, though in the severe Little's advice is good—to deal with the tibial tendons first and overcome the inversion of the foot, and at a later date to divide the tendo Achillis. The value of this proceeding consists in the fixed os calcis offering a resisting point from which the surgeon is enabled to stretch out and unfold the contracted inverted sole.

Division of the Tendo Achillis.—The patient should be turned on the abdomen and the tendon made tense by means of an assistant. The surgeon should then insert a sharp-pointed or round knife flatwise from behind forward by the side of the tendon as far as its anterior surface, when it should be turned laterally in front of the tendon and its cutting edge directed backward toward the tendon, and with the slightest sawing motion the tense cord may be divided, care being observed to do this completely; otherwise, failure will follow. During this procedure the surgeon should keep his finger upon the tissue to be divided, and immediately on the withdrawal of his knife close the opening with his finger or thumb, the assistant relaxing the parts at the moment he feels resistance to cease. A dossil of lint should then be applied to the puncture and fixed by strapping, this dressing being left for three days. If any suspicion exist of the posterior tibial artery having been wounded, as indicated by arterial hemorrhage and blanching of the foot, the dressing should be left on for at least a fortnight and all mechanical treatment postponed. It is, however, an exceptional circumstance for any harm to follow the puncture of the artery. Little, with all his experience, informs us that he has only once seen any trouble from this circumstance.

After the operation the foot, in its deformed position, should be bound to a flexible metal or other splint for three or four days, till the immediate effects of the operation have subsided, when the foot should be at once brought to the required position and retained there by splints and bandages.

Division of the posterior tibial tendon should be performed with the child upon its back, with the limb to be operated upon rotated well outward. The surgeon should take charge of the foot, and his assistant of the knee. The tendon should be divided about an inch or an inch and a half above the extremity of the inner malleolus. In thin subjects, on abducting the foot, the tendon may be felt at the spot indicated; but in fat persons, and when the tendon cannot be made out, the surgeon knows it lies along the inner edge of the tibia, "exactly midway between the anterior and posterior borders of the leg on its inner aspect."

At this spot the knife should be inserted perpendicularly to the surface through the fascia for about half an inch, an opening in the fascia being made sufficiently free to admit of the introduction of the probe-pointed knife, which must next be inserted. This knife can then be introduced perpendicularly, close to the bone, between it and the tendon to be divided, when its edge should be turned toward the tendon and the operation completed by a slight sawing movement. It is not always necessary to change knives during this operation; some operators, indeed, never do so. It is safer, however, to adopt the practice in fat subjects when some uncertainty exists as to the exact position of the tendon. As soon as the tendon has been divided a dossil of lint should be applied, as in the former operation.

Some surgeons prefer to divide the tendon of the long flexor muscle at the same time; as a rule, this is unnecessary.

Division of the anterior tibial tendon can be performed with the patient lying on his back and the foot extended, the tendon being in this way made prominent in

front of the inner malleolus. The knife should be inserted at this point behind the tendon and its edge turned forward, when the tight cord can be divided, the foot being at once flexed and the punctured wound covered with lint and strapping. It ought to be kept in a splint for several days after division of the tendo Achillis.

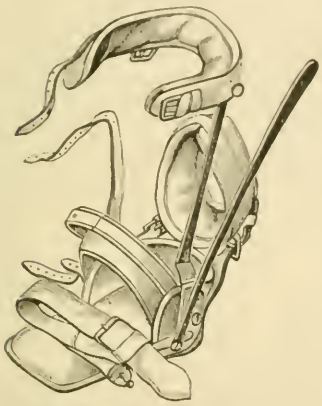
When all these tendons are divided at the same operation, the after-treatment must be the same.

Division of the peronei tendons for talipes valgus is easily accomplished by adducting the foot and introducing the knife behind the external malleolus, between the tendons and the fibula, the tendons being cut, on turning the edge of the knife toward them, with a sawing movement. Some surgeons advocate a higher division of these tendons to obviate their retraction, union taking place between the tendon and the sheath.

It is unnecessary to describe the operation for division of the *plantar fascia* or other tendons, as the practice in all should be conducted on principles identical with those already described.

Mechanical Treatment.—However necessary these operations may be in any given case, it ought to be remembered that they are only preparatory to the mechanical treatment which is subsequently to be carried out. That they are not always necessary has already been shown, mechanical treatment generally being amply sufficient of itself to effect all the surgeon desires.

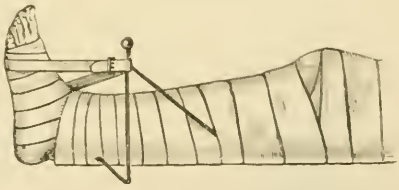
Fig. 475.



Little's Modification of Scarpa's Shoe for Talipes.

In one case after the division of the rigid tendon or tendons a cure may be effected by means of strapping, as already illustrated (Fig. 473); in a second a simple inside or outside splint with strapping or bandages may be

Fig. 476.



Mr. Davies-Colley's Splint for Talipes Equino-Varus.

enough; in a third the simple splint figured in Fig. 474 answers every purpose; while in a fourth Scarpa's shoe is required (Fig. 475), or some of its modifications. A shoe with a ball-and-socket heel-joint which Messrs. Krohne made for me is strongly to be recommended, and in Fig. 476 is another, suggested by my colleague, Mr. Davies-Colley, which for extreme examples of talipes is inexpensive and stands unrivalled.

In all the principle embodied is the same—the separation of the divided ends of the tendon and the deposition of new material between them. The splint invariably should be applied and fixed to the foot in its deformed position and the separating process carried out on the third or fourth day. In many I have brought the foot into position directly after the division of the tendons with nothing but good results.

If failure follows the first operation, a second may be performed; but the hope of a successful issue under these circumstances is far from good.

Barwell has recently revived the old practice of elastic bands to stretch the tendons in lieu of dividing them, and in some cases it is a valuable practice, but as a substitute for tenotomy it cannot be recommended.

There are, however, cases of talipes equino-varus which are amenable neither to subcutaneous tenotomy nor to mechanical appliances, as well as others which have been treated by these measures and have failed, or which are so severe as to make it certain that a long interval of time must of necessity be spent in the attempt to bring about a cure, even if such a result were probable or possible; and under these circumstances surgeons have sought for more expeditious and efficient means of treatment. With such a view, Dr. Little, the pioneer of tenotomy in this country, suggested, so long ago as 1854, "that in inveterate varus the treatment might well be commenced in robust subjects by ablation of the os cuboides," and the late Mr. S. Solly in 1857 carried the suggestion into effect.[1] The case not proving very successful, the practice met with no

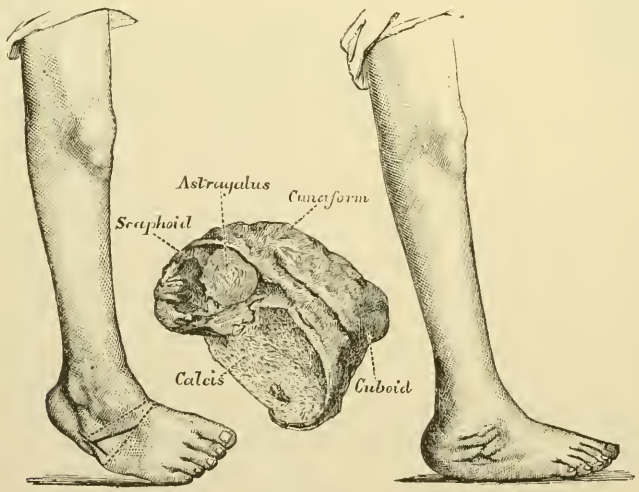
[1] *Med.-Chir. Trans.*, 1857.

encouragement, and the operation was not repeated till Mr. Richard Davy, an old pupil of my own, performed it at the Westminster Hospital in 1874 on a boy æt. 15 with such a "striking immediate result that the sole of the foot could with force be placed in a natural position," and he repeated it in 1875–76. In 1872, Mr. Edward Lund went a step farther and removed from a boy æt. 7 both astragali in a case of severe double talipes with some perceptible improvement. This measure he repeated in March, 1878.[1]

In October, 1875, however, my colleague, Mr. Davies-Colley, adopted a new method, and on the suggestion of Mr. Howse removed from a boy æt. 12 a wedge-shaped piece of the tarsus, without paying any regard to its articulations, by means of "an incision three inches in length along the outer border of the left foot from the middle of the os calcis to the middle of the fifth metatarsal bone, and a second across the dorsum of the foot from the centre of this incision two inches long."[2] Both feet were operated upon at intervals of six weeks, and in less than ten weeks from the second operation the wounds were quite healed and the boy could walk without assistance. In November, 1876, Mr. Davy performed the same operation.

All these proceedings are sound in principle, and in cases of talipes in which minor measures have been tried and have failed, or in which the probabilities of their success are slight, and time and expense are questions of importance, they should be entertained. I believe, however, that Mr. Davies-Colley's operation is the best for talipes equino-varus, particularly when the varus is worse than the equinus, though Mr. Lund's operation is probably of value under the reverse conditions. I say this after having had opportunities of seeing several of Mr. Davy's and one of Mr. Lund's cases, and having carefully watched throughout its treatment Mr. Davies-Colley's. Entertaining these opinions, I performed Mr. Davies-Colley's operation on June 18, 1878, and with such a good result that I now give drawings of the boy's foot before the operation (Figs. 477, 478) and subsequent to it, with an outline of the portion of bones removed (Fig. 479).

Fig. 477. Fig. 479. Fig. 478.



Foot before Operation. Bones Removed. Foot after Operation.

The case was that of a boy æt. 12 who was born with talipes equino-varus of the right foot and went under surgical treatment when eight months, and again when five years, old, but with no permanent relief. On admission into Guy's, under my care, on June 12, 1878, the heel of the right foot was much drawn up and the foot so twisted inward as to cause the sole of the foot to face the median line of the body, as in a complete sub-astragaloid dislocation. The head of the astragalus was very prominent and the tip of the inner malleolus approximated the base of the metatarsal bone of the great toe, the tubercle of the scaphoid being buried in the abnormal depression. By no force could the foot be restored to a better position, although the tendo Achillis and tendon of the posterior tibial muscles could be made tense. Under the circumstances described it was tolerably clear

[1] *Brit. Med. Journ.*, November 2, 1878.
[2] *Med.-Chir. Trans.*, 1877.

that by no tenotomy or mechanical means could any hope be entertained of restoring the foot to a good position, and I consequently determined to perform Mr. Davies-Colley's operation.

This I did on June 18, 1878, by an oblique T-incision of the soft parts and the application of a keyhole saw beneath the tendons and soft parts, made after Esmarch bandages had been applied as a tourniquet.

The wedge of bone I took away is represented in Fig. 479 and was removed entire, great care being used to protect the tendons and soft tissues, and particularly those of the sole, by the introduction of a flat retractor during the sawing process.

The day following the operation the temperature went up to 102.4°, but fell the next day. On the third day, when the wound was dressed for the first time, it was 99.6°, and during the progress of the case it never deviated beyond a point or so from that degree. On July 11, the bones having fairly united and the wound nearly closed, Davies-Colley's talipes splint was put on and the limb swung.

On September 10 the boy got up, and the sole of the foot was found, on his standing, to be perfectly flat. An immovable splint was then applied, and the boy left for the country. On October 20 he returned to have the tendo Achillis divided, with the view of giving more movement to the ankle-joint, and some success has followed the measure. He can now (November 10) walk fairly well with his foot as flat to the ground as the unaffected one. I have had three other cases since, and seen about six more, which have been equally successful.

Spurious Valgus, or Flat-Foot,

is a common condition in feeble boys and girls who stand much or take too much exertion. It is due to a giving way or yielding of the plantar arch and fibrous structures of the sole of the foot, "the keystone of the arch"—the navicular bone—eventually sinking with the astragalus and inner cuneiform bones. (*Vide* Fig. 480.) In some cases there is as a secondary consequence contraction of the peronei muscles and impaired movements of the ankle-joint. This stretching of the tissues gives rise to more or less pain, and in extreme cases to inability to walk, or even to stand. This affection is constantly associated with lateral curvature of the spine.

Fig. 480.

Spurious talgus

Treatment.—In the milder form of cases, when the foot can readily be restored to its normal position, a cure may be brought about by periodical rest, gentle exercise, and mechanical support, by means of strapping or the introduction of a firm pad or metal plate, to support the plantar arch, into the hollow of a boot made with a straight inside edge and low heel. Tonics and good air and living and the free movement of the joint are essential.

In a worse class of cases it is well forcibly to flex the foot and restore the parts to their normal position, and then fix them so by means of a plaster-of-Paris bandage.

In more extreme cases some divisions of the tendons may be permissible, and in the very worst operative interference may be justifiable. Dr. Ogston of Aberdeen has suggested the union of Chopart's joint by pegging.

In examples in which much pain exists nothing but absolute rest will be of any use, and in such the local signs of inflammation of the overstretched parts are often evident, and therefore fomentations, etc., may be employed.

Knock-Knee.

Knock-knee, like flat-foot, is primarily due to mechanical yielding of the internal ligament of the knee-joint from want of power, and at a later date to the overgrowth of the inner condyle of the femur with the lower end of the diaphysis, from the want of the controlling influence of pressure which normally is applied through the leg bones. It is found in growing boys and girls who stand too much and carry heavy weights, and in those of feeble power from either natural or acquired causes. It is not rarely seen with rachitis.

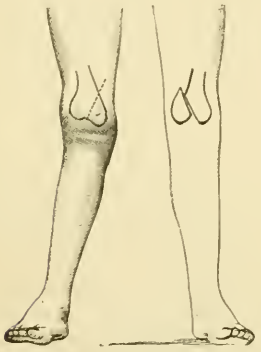
Treatment.—It can be treated on principles based upon the facts just briefly stated, and not purely by mechanical means. To put irons on the limb of a feeble subject is a mistake; for where the child is too weak to support his own frame without injury, to give him more to carry must be hurtful. Young children should be taken off their legs

as much as possible and provided with proper food and such tonic medicines as seem requisite. The weakened ligaments should have time given them to contract and become strong. Older children should be limited in the amount of exercise, rest and exercise alternating at regular intervals. When walking half an hour causes pain or aching, something less should be allowed, and so on. Exercise sufficient to get and keep the muscles in order may be allowed, but not sufficient to tell upon the weakened ligaments. In other cases, as an additional means, strapping the knees may be of great use. In more severe cases splints or irons should be employed. These latter instruments should extend from the pelvis to the foot and be well jointed. In *very severe* examples operative interference may be justifiable, and the surgeon has a choice of three measures:

1st. *Ogston's operation* of obliquely sawing or chiselling *off the inner condyle* of the femur and forcibly straightening the bent limb, which is kept fixed by splints and bandages during the period of repair (Fig. 481).

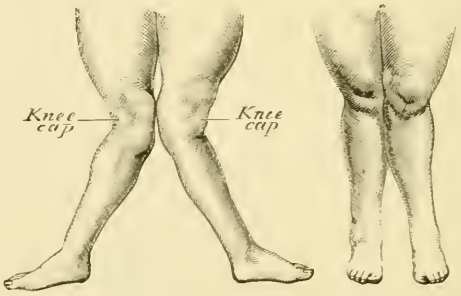
2d. *Macewen's operation* of dividing with a saw or chisel the shaft of the femur *above the condyles*, forcibly bringing the limb straight, and retaining it in its new position for five or six weeks while the bone unites (Fig. 482), the cutaneous incisions in both these operations being merely enough to admit the cutting instrument or saw.

FIG. 481.



Drawing illustrating Dr. Ogston's Operation. (*Right* limb shows line of section of the inner condyle of the femur. *Left*, inner condyle brought to required position.)

FIG. 482.



Appearance of Limbs before and after Macewen's Operation in a Patient æt. 33. (The legs and feet rotated outward and abducted.)

3d. The *forcible straightening* of the limb, as advocated by Delore, pressing it straight, and giving time for repair.

Of these three, the second, or Macewen's, is to be preferred, the results being as good as, if not better than, Ogston's operation; and the operation is attended with less risk, the knee-joint not being opened. My colleagues and I have performed it on many occasions, and always with success. In the drawing above—one of the worst cases I have undertaken, in an adult æt. 33—the operation gave three inches to the patient's height (Fig. 482).

Delore's operation is not to be advised, since it means not only the abruption of ligaments, but often the separation of epiphyses, and with such separation the dangers of local disease starting from the seat of injury, and the probable arrest of growth in the limb as a later consequence. Farabeuf and Mikulicza have fairly established this fact (*Gaz. Méd. de Paris*, January, 1880).

TENOTOMY FOR CONTRACTED LIMB, ETC.

Besides all these recognized affections, there are many other conditions in which tenotomy is a valuable operation. Thus, in the contracted limbs which are associated with hip, knee, or other joint disease, it is often necessary to divide the rigid and contracted tendons or muscles that forbid the limb being straightened by the application of any ordinary or justifiable force, while mechanical means can then complete the object the surgeon has in view. It is better to divide than to tear a tendon.

In 1871 I saw a boy æt. 14 who for years had had repeated attacks of pain and inflammation about his great toe, more particularly after overwalking. He had been under the care of many medical men, who had treated him for gout, etc., but who had never compared the sound with the affected toe. When I did this, the source of the evil was very apparent; for the long extensor tendon was clearly contracted, and at its insertion into

the base of the extreme phalanx there was much thickening. I divided the tendon, and recovery at once ensued.

The biceps muscle of the arm is also at times so contracted as to prevent extension; the adductor muscles of the thigh are so contracted as to cause great apparent shortening of the lower extremity, and, as a result, limping. In both of these cases tenotomy is of great service. In fact, any tendon may contract under the influence of disease, and require division.

Contraction of the Fingers.

In this curious affection, which generally appears in the little finger and subsequently involves the ring finger, and in which the palmar fascia chiefly, and the flexor tendons secondarily, produce a permanent contraction of first one and then the other finger, so as to draw them into the palm, some operation is called for.

It often attacks both hands, together or consecutively. It is said to be found more frequently in gouty or rheumatic subjects than in others, but I have failed to verify this statement. It is also difficult to trace the origin of the disease to any local injury. In fact, this affection is somewhat obscure. It may attack the middle finger or any and all of the fingers, but more commonly it is the two outer. From its symmetry it has probably a constitutional, and not a local, origin. It is often hereditary, but possibly not more so than any other deformity.

Treatment.—By fixing the contracted fingers in a flexible splint and gradually stretching them much may be done, and in several cases I have effected a complete cure by these means. But it is difficult for men-patients to submit to this inconvenience, and, as a consequence, the surgeon is consulted only when the disease is severe and the finger by its contraction has become useless, if not worse than useless. Under these circumstances the free division subcutaneously of all the tense tissues may be called for, as recently ably advocated by Mr. W. Adams (*Brit. Med. Journ.*, June 29, 1878). His operation and treatment are as follows:

1. The subcutaneous division of all the contracted bands of the palmar fascia and its digital prolongations by as many punctures as might be necessary, cutting from above downward with the smallest tenotomy knife.

2. Immediate extension of the contracted fingers, the fingers and hand to be bandaged to a splint.

3. The bandage not to be removed until the fourth day, when the punctures will be found to be healed.

4. Extension splint to be worn night and day for two or three weeks, and afterward at night for three or four weeks, motion being employed every day.

Dr. Madelüng of Bonn (*Berliner Klinische Wochenschrift*, No. 15, 1875) believes that this condition of finger, known as "Dupuytren's contraction," is due to the absorption of the numerous small deposits of fat which in healthy young and middle-aged subjects exist between the connective-tissue bands of the palmar fascia and the short fibres which connect this fascia with the superjacent integument. This fascia, consequently, under the influence of pressure, falls into a state of chronic inflammation and becomes contracted. He then describes how Busch of Bonn treats such cases with great success. In a case, for example, of contraction of the little finger, he raises an angular skin flap from the palm of the hand, its base being at the root of the finger, and then cuts away, bit by bit, the tense fascia beneath as the finger is being straightened. He then replaces the flap and fixes it with sutures. The finger is left free for some days after this operation, but as soon as granulations appear a cylinder of wood is placed in the palm for a few days, and after this the finger is extended and kept so by means of a straight splint applied to the back of the hand. This should be removed daily and the finger moved. At the end of three or four weeks the hand is left free. Dr. Madelüng has never seen this operation fail (*Med. Rev.*, May 26, 1875). I have adopted this practice in several cases with excellent results. In the same way one or more toes may be so affected, and tenotomy may be called for.

Rigid Atrophy.

Muscles that atrophy occasionally contract and become rigid, but this rigidity must not be mistaken for the spasmodic contraction of a muscle or group of muscles that is so common in progressive disease, more particularly of joint disease, although it often follows upon that form: indeed, it seems generally to be the consequence of some long-continued

spasm, atrophy following from exhaustion, inflammation of the muscle, or what is called "rheumatism." It is seen more commonly in the flexor muscles of joints than in any other, and, as a special affection, in some cases of *wry-neck*, where the sterno-mastoid muscle is at fault.

Treatment.—When the muscles are not too rigid, much may be done by rapid extension under the influence of an anæsthetic or gradually by means of splints, manipulation, or india-rubber bands, etc., suited to the wants of the individual case. When these means are ineffectual or the parts too rigid to allow of their application, the subcutaneous division of the tendon of the muscle or muscles may be performed upon the same principle under which tenotomy is practised in contracted tendons.

Wry-Neck is an example of this affection due to a contracted sterno-mastoid muscle. It may be that the sternal or clavicular origin may be alone at fault, it being exceptional to find both divisions of the muscle affected.

Treatment.—Under such circumstances, when the muscle refuses to be stretched by mechanical appliances, the half involved alone requires division, followed by extension when union has taken place. In these difficult cases it seems wise, as a rule, not to bring the divided ends of the muscle so closely into contact as the surgeon usually does after division of a tendon.

One of the worst cases of the kind I ever had to treat was in a child æt. 7 in which both origins of the muscle required division. I brought the head up to the required position on the second day and kept it there, an excellent result ensuing. In another, which I treated in 1870, in a child æt. 6, with Mr. Duke of Battle, the muscle of the left side was two inches shorter than that of the right from contraction of its sternal half. I applied extension on the third day, after the division of the contracted portion, and brought the head into its right place, keeping up the extension by means of a piece of india-rubber band an inch wide, which was fastened to a skull-cap on the opposite side of the head and passed backward across the shoulders and beneath the axilla of the affected side to fasten to a good thoracic belt (Fig. 483).

Fig. 483.

Cap and Band for Extension in Wry-Neck.

These cases of wry-neck due to contraction of muscles are always associated with some arrest of growth in the upper and lower jaws on the affected side.

Mr. de Morgan informs us (*Med.-Chir. Rev.*, 1866) that in a case that failed to yield under such treatment he took away a piece of the spinal accessory nerve with permanent benefit, the sterno-mastoid and trapezius muscles being of necessity paralyzed. This operation has been repeated, but with only exceptional success.

The operation of dividing the sterno-mastoid muscle, either wholly or in part, at its sternal or clavicular origin, must be subcutaneous and requires much care, for important parts lie behind the muscle which may be injured. A punctured wound down to the muscle should be made over the part to be divided with a sharp-pointed tenotomy knife; a blunt-pointed knife ought then to be introduced, with its edge turned toward the muscle, close to its bony attachment, and all resisting fibres divided by turning the edge backward, an assistant putting the muscles fully on the stretch; the muscle usually gives way with a distinct snap. The thumb or finger must then be applied to the part and a pad adjusted, sufficient pressure being made to prevent bleeding, but no more. As already stated, extension should be made early in the case, after the second or third day, and the means adopted in the example quoted seems to be the best; it succeeded, at any rate, where the usual instruments failed.

When both insertions require division, it should be effected by two different punctures. Some surgeons prefer to divide the muscle from behind forward, but there is greater risk of injuring the deep parts by this practice than by the one advised.

I need scarcely add that where wry-neck is due to spinal disease no such treatment as the above is applicable.

CHAPTER XXX.

CONTUSIONS, SPRAINS, WOUNDS, INJURIES OF JOINTS, AND DISLOCATIONS.

Sprains may be very slight or very serious indirect injuries. They include more or less severe overstretchings, if not lacerations, of the ligaments that bind the bones of an articulation together, some fracture or tearing away of the bone at the attachment of the ligaments—"sprain fractures." In children under ten, sprains of joints are liable to be complicated with some epiphysial separation or incomplete fracture near the epiphysial line, or some crushing or compression of the spongy bone tissue. In the more severe instances are included lacerations of the muscles, tendons, and soft parts that surround the joint. All such accidents require rest and time in their treatment in order that repair may be complete, since neglected sprains are often the cause of joint or bone disease.

Contusions of joints as direct injuries always ought to be regarded in a serious aspect, for a large amount of internal mischief may often be sustained with very slight external evidence of injury, and under certain conditions of health a slight blow upon a bone is often enough to set up severe local action or to excite chronic changes which may involve the integrity of the joint. During the period of the growth of bone in children these observations have great force. The nature of the accident and the amount of force concentrated on the joint form the best index to the case, and under all circumstances the prognosis should be guarded and the treatment cautious.

Treatment.—"In sprains of joints rest is the first principle," said John Hunter in 1787 (MS. lectures), and at the present day the same words are as pregnant with truth as when then spoken; indeed, in simple cases of sprain by such treatment alone will convalescence be established. When swelling and effusion into the joint ensue in the course of the second or third day after the accident, the evidence of internal injury is more marked; for such effusion means inflammation or synovitis, which is to be treated by absolute rest, ensured by the application of a splint, the local use of cold or warmth, according to the comfort afforded by either, and occasionally by leeches.

If swelling of the articulation follows immediately upon the injury, effusion of blood into the joint is indicated with or without fracture, but always with severe local mischief. Such cases should be treated by the employment of a splint, to ensure immobility of the articulation, elevation of the injured joint with the patient reclining, and the local application of a bag of pounded ice or Leiter's metallic coil (Fig. 9), these means being maintained until the hemorrhage has ceased, all risks of inflammation of the joint are gone, and repair appears to be going on satisfactorily. As soon as the primary effects of the sprain and all signs of inflammation have passed, the application of pressure to the joint by means of a bandage or strapping with passive movement is very striking. When the joint is rendered very tense from effused blood, it may be aspirated.

When the muscles over the shoulder-joint are severely bruised by a fall, much local pain may be produced, as well as want of power in the arm, exciting a fear of either bone or joint mischief; but a careful examination will show, if no roughness in the examination be used, that the joint can be passively moved without exciting pain, although if the patient attempts to set the muscles in action pain is produced. This point is one of clinical importance, indicating that the mischief is in the muscle, and not in the articulation, the pain being excited by muscular action, and not by joint movement.

In delicate children all falls upon the hip followed by pain should be treated by rest and extreme care, for a large number of cases of hip disease originate from some such trifling cause; and there is good reason to believe that the majority of hip-joint affections might be prevented by proper attention after slight injury.

After-Treatment.—When the immediate effects of the sprain have passed away, the local use of a stimulating liniment and moderate friction of the part expedites the cure, and at the same time gives comfort to the patient. A local warm bath at intervals likewise relieves the stiffness of the joint. Whenever movement excites more than a momentary pain, rest should be observed; and if the pain continue, some chronic inflammatory change ought to be suspected and treated. When weakness of the joint alone remains, a good bandage or strapping around the part, to give support, is of great benefit.

Where much laceration of ligament has taken place, it is at times necessary for the joint to have some permanent artificial support, in the form of either a splint, felt, leather casing, or bandage; for no parts are repaired with less permanent power than ligaments.

In the wrist, when much swelling exists, a sprain may be mistaken for a fracture or a fracture for a sprain, as fractures about the end of the radius are generally impacted, and not, consequently, attended by crepitus. Much care is necessary in the diagnosis of such cases. Many sprains of the ankle are also really cases of fracture of the fibula above the malleolus. The popular notion that a severe sprain is worse than a fracture is in the main true; and when the sprain is neglected, the case is always more tedious than that of a broken bone.

Wounds of Joints.

These are always serious accidents, yet as a whole, if treated with discretion and at an early period of their existence, they are fairly successful in their issue. Lacerated, incised, and punctured wounds are met with, and the symptoms that follow any one of these accidents are by no means commensurate with the extent of the local injury; for a slight or punctured wound is often followed by severe and destructive local changes, when an extensive one heals without giving rise to any mischief.

A joint is known to be wounded when its contents escape, the oily, glutinous nature of synovia rendering its flow very manifest. In fat subjects, however, wounds over joints give exit to an oily fluid simulating "joint oil," but such fluid is not sticky when rubbed between the fingers, as is synovia. Joints are sometimes wounded without any evident escape of their contents; such doubtful cases are clinically to be treated as cases of wound. In every case of wounded joint, however trivial, and in all doubtful cases of wounded joints, the *prognosis* must be very guarded and the *treatment* cautious.

Treatment.—A clean incised wound should be well cleansed with carbolic or iodine water and its edges accurately adapted with sutures; a contused or lacerated one should likewise be well washed and the joint syringed; and if the edges of the wound are brought partially together, sufficient opening should be left for drainage. The wound in both cases should be dressed with some absorbent antiseptic dressing such as iodoform or carbolic gauze. Probing must be avoided, and the joint should be kept in absolute repose by the application of a splint. Cold should then be applied, nothing checking pain or subduing inflammation and effusion better. The cold, however, to be of value, must be persistently maintained, as any intermission of its use is almost sure to be followed by increase of pain and effusion. To seal hermetically a small wound with a piece of lint soaked in the compound tincture of benzoin and at the same time apply cold is excellent practice. Should an interval have passed between the receipt of the accident and the application of the cold, and much joint inflammation exist with constitutional symptoms, the application of leeches to the joint, and subsequently of cold, is beneficial. In exceptional examples, where cold is not tolerated, warm fomentations must be substituted. Opium is always of use, the patient being kept fairly under its influence by one grain two or three times a day. Mercury is useless. In very sthenic cases antimony may be given, and colchicum where gout is suspected.

When all acute symptoms have subsided and chronic effusion remains, the application of a blister or of blisters expedites the absorption of the effused fluid, and the benefit of pressure by the adjustment of well-applied strapping is very great. In feeble patients tonics are required. Should suppuration appear, active treatment is called for, such as a free incision into the joint, or other means which will be considered under the head of "Suppurating Joints."

Extensive wounds of large joints complicated with other injuries had better be treated by amputation or excision.

DISLOCATIONS.

A joint is said to be dislocated when the articular surface of one bone is displaced from another. When the bone is wholly displaced, the dislocation is called *complete;* but when otherwise, *partial* or *incomplete.*

When a wound communicating with the joint complicates the case it is known as a *compound*, and when not so associated as a *simple*, dislocation.

Congenital dislocations are cases of malformation, and the displacements of bones produced from disease are accidental complications of a more serious affection. In the present chapter neither of these two conditions will receive attention.

Flower and Morris's Middlesex Hospital statistics (*Holmes's System*, vol. i., 3d ed.)

tell us that, out of 756 cases of dislocation of the upper extremity treated in twenty-six years, 20 were of the clavicle, 16 of the scapula, 375 of the humerus, 112 of the elbow, 137 of the thumb, and 78 of the phalanges. At Guy's, during the ten years ending with 1883, out of 46 dislocations of the lower extremity, 25 were of the hip, 7 of the patella, 10 of the bones of the foot, and 4 partial of the knee.

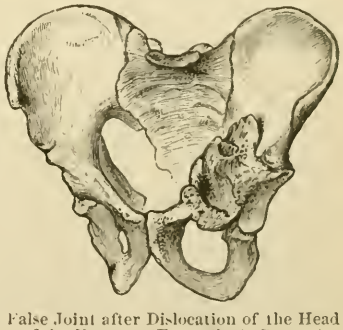
Dislocations are mostly caused by external violence, but they occasionally occur from muscular action, as in dislocation of the lower jaw. I have known, however, the head of the humerus to be displaced by the exertion used in the violent throwing of a stone and by the spasm of muscles in an epileptic fit. I have likewise seen the hip-joint dislocated by mere muscular action. Schoolboys are also familiar with the dislocation of the thumb at the carpal joint, which some young persons who possess relaxed ligaments are capable of producing at will.

Laceration of the ligaments more or less complete, as well as of the capsular ligament, is a usual accompaniment of all dislocations, with more or less injury to the muscles and soft parts that surround the injured articulation. In exceptional cases the capsule, instead of being torn, may be simply stripped off the bone. At times the nerves are pressed upon or lacerated and the main artery pressed upon, stretched, or divided. In shoulder dislocations the circumflex nerve is frequently torn, and the popliteal artery is injured in knee dislocations. In all joints, more particularly in the ankle, dislocation may be complicated with fracture.

After a dislocation has been reduced most of these injuries are steadily repaired, although some weakness of the joint often remains, and some impairment of mobility. When nerves have been injured, more or less complete local paralysis or want of power follows in the muscles supplied by the injured nerves.

When a dislocation has been overlooked or neglected, secondary and, in a measure, reparative changes take place and a new joint is formed. To effect this, new products are poured out around the bone in its new position, which organize and ossify (Fig. 484). The cavity thus formed becomes lined with a dense layer of fibrous tissue, putting on the external aspect and serving instead of cartilage. The head of the bone becomes at the same time altered in shape and surrounded by the condensed cellular tissue of the part, which answers for a new capsule. A large amount of mobility is often secured, particularly in the ball-and-socket joints. When, however, the original articular cavity becomes gradually filled in with fibrous tissue, the muscles, tendons, and soft parts that have been torn or misplaced make fresh attachments, and ossific matter is deposited in the tendons.

FIG. 484.



False Joint after Dislocation of the Head of the Femur. (From Sir A. Cooper.)

How long these secondary changes take to form is not yet decided. In some patients they doubtless occur rapidly and in others slowly, as Brodhurst and Fournier both (*St. George's Hosp. Rep.*, 1868) record a case in which the cartilage of the acetabulum was found healthy and the cups unfilled three years and ten years respectively after a dislocation. Cadge also records a singularly instructive example (*Med.-Chir. Trans.*, vol. xxxviii.) of an unreduced dislocation of the head of the femur upward between the two anterior spinous processes of the ilium of sixteen years' standing, in which "the new bone was deposited in such abundance that it formed a new and complete acetabulum—so complete as, indeed, to hold the thigh bone suspended after all the soft parts were removed and make it requisite to saw off a large piece of the new bone in order to set the femur at liberty. The new cavity, thin at its walls and smooth on its outside, was lined by a dense pearly white tissue which resembled fibro-cartilage. The head of the femur was still covered with cartilage. The old acetabulum had disappeared, partly by the absorption of its cotyloid margin by a deposit of new bone, and partly also by a mass of dense fibrous tissue."

DIAGNOSIS AND SYMPTOMS.—Typical examples of dislocation, when seen at an early period of their existence, are not difficult of diagnosis, although partial and even complete dislocations some days after the accident, when swelling of the parts has taken place, are often obscure. The frequency with which such cases are overlooked, even by good men, forbids our saying they can always be made out.

In every case of suspected dislocation the surgeon should compare the sound with the injured side, and in difficult cases, in young or sensitive subjects, he should make the

examination with the patient anæsthetized. In doing this he will at once detect the most obvious result of any dislocation—deformity—and be able to make out the direction the displaced bone has taken; he, moreover, will see whether the limb is longer or shorter, or more abducted or adducted, than its fellow. The patient will have lost all power of voluntary movement; the surgeon, by manipulation, will discover that where mobility formerly existed such will be seriously impaired, and that the attempt to obtain it causes severe pain. There will be an absence of crepitus, unless some days have passed since the accident, when the crepitus of effusion into the joint or into the bursæ about the joint or tendons will often be felt. *Deformity, loss of the power of voluntary motion*, and *impaired mobility*, coming on after an accident, are the three most marked symptoms of dislocation. Indeed, these symptoms by themselves, with the absence of crepitus, are usually enough to enable the surgeon to diagnose a dislocation from a fracture. They are not enough, however, to distinguish it from the separation of an epiphysis—an accident prone to affect subjects under the age of twenty-one.

Treatment.—In all cases the reduction of the dislocation or displacement should be effected as soon as possible, delay being justifiable only when the appliances required for the purpose are not at hand or the diagnosis is uncertain. Most dislocations, not excluding those of the hip, may be readily reduced directly after their occurrence by extension or manipulation without the aid of an anæsthetic; but when any time has been allowed to pass and the immediate constitutional effects of the accident have subsided, it is a fair question whether it is advisable to attempt reduction before anæsthetizing the patient, for under the most favorable circumstances, without this aid, much force will to a certainty be called for, whilst with it the gentlest manipulation is often enough. Indeed, I believe it to be wiser for the surgeon to delay any attempt to reduce a dislocation till an anæsthetic can be obtained than to make it without, for the slight harm that ensues from the delay is more than compensated by the great good secured by its use. In no department of surgery is the benefit of anæsthetics better demonstrated than in this, for where force formerly reigned gentleness now suffices, and where difficulty and pain were common accompaniments facility of reduction and painlessness are now the rule. Their use has superseded the old treatment by venesection, tartar emetic, the string of students, and the pulleys. Under their influence all muscular spasm ceases to be a force which has to be overcome, and the surgeon has simply to replace the bone through the rent in its capsule by such gentle manipulative acts as the special requirements of each case appear to indicate. The facility, however, with which a dislocation is reduced by manipulation turns much upon the surgeon's knowledge of the way the dislocation was produced, for, in a general sense, the best way to reduce a dislocation is to make the head of the bone retrace the course it followed after it had first burst through its capsule, the untorn parts in the capsule being doubtless the main obstacle to reduction; muscular spasm is eliminated by the use of an anæsthetic.

In neglected cases of dislocation, where false joints and adhesions exist, force is called for to break them down and pulleys may be wanted, but they must always be employed with the greatest caution and under a healthy fear, for not only may the axillary artery be torn and ligaments lacerated, but worse injuries may ensue; thus, in Paris, in 1864, the fore-arm of a woman æt. 64 was torn off at the elbow-joint in the attempt to reduce a dislocation in the humerus, and in London, more recently, the same dreadful accident has taken place. Agnew in his *Surgery* gives 24 cases of injury of the axillary artery brought about in attempts at reduction of old dislocations of the humerus, and of these 15 were fatal.

After-Treatment.—After the reduction of a dislocation the limb should be kept at rest and fixed by bandages on a splint; Sédillot's rule of "simply placing the joint in a position the opposite of that in which it was when the dislocation occurred" is sound. When any signs of inflammation show themselves, cold, in the shape of ice in a bag, should be employed; leeches are seldom called for.

At least three or four weeks are required for repair to take place before any useful free movement of the joint can be allowed, although, when no inflammatory symptoms appear, passive movement may be permitted at the end of two weeks; in dislocation of the hip no walking or standing should be permitted for a month.

When reduction cannot be accomplished after a reasonable attempt, a second one may be made at a subsequent period after the effects of the first have passed—that is, if any sound hope exists of success being secured—some modification of the means employed probably suggesting themselves to the surgeon upon reflecting as to the peculiarity of the case and the cause of his failure.

When the patient is an adult, the difficulties and prospects of the case should be laid before him and his opinion taken—not, however, as to the desirability or the reverse of the attempt, for such an opinion belongs to the surgeon and his colleagues only, but as to the risks that must be run; for in many cases failure of reduction—more particularly of forcible reduction—is followed by some destruction of the new joint that nature has partially formed, by some inflammatory change that may end in the destruction of the joint or in rendering its usefulness still less promising.

With respect to the propriety of attempting the reduction of an old dislocation no definite rules can be laid down, and since anæsthetics have been introduced those originally given by Sir A. Cooper and generally followed require modification. Sir A. Cooper gave three months as a limit to the attempt in the shoulder, and eight weeks in the hip; yet Sédillot reduced a dislocation of the shoulder more than a year after its receipt, Brodhurst on the one hundred and seventy-fifth day, Smith (United States) at the seventh and tenth month, whilst Bresehet reduced a dislocated hip on the seventy-eighth day, Travers and my colleague, Mr. Durham, at the fifth month, Blackman (of Cirencester) at the sixth month. Yet such cases must be rare. Ball-and-socket joints are also more readily replaced than others. The best guides the surgeon possesses for his decision are found in the amount or the absence of repair that is present in the dislocated joint. When the movement is good, there is small reason for making the attempt; for, writes Fergusson, "after three months the use of the limb is not, when reduced, greater than that which it would have acquired in its dislocated state."

When the movements are very limited, a cautious attempt to reduce the dislocation is hardly likely to be followed by a bad result, at whatever period it is made; but, as previously stated, the patient and the surgeon should take counsel together on the point and share responsibility.

To facilitate the reduction of an old dislocation, it is needless to say, some anæsthetic should be employed; and as a primary step all adhesions should be broken down by free rotation or forcible movements of the joint. When this has been effected, the head of the bone ought to be replaced by manipulation or by slight extension, forrible extension being inadmissible. When tendons are very rigid and forbid movement, they should be divided subcutaneously; but this should be done some days before reduction is fully attempted.

Compound dislocation is one of the most serious accidents that can befall a limb, and in the larger joints is generally complicated with fracture or torn arteries. In the knee-joint the popliteal artery is generally lacerated, and under such circumstances amputation is the only resource. In the ankle-joint, where the accident is most commonly seen, the case should be treated as one of fracture and wounded joint by immovable splints after its reduction, and the persistent application of cold. In exceptional cases only, when the soft parts are much injured, and in very feeble subjects, ought amputation to be thought of, excision of the articular surface being always a point for consideration. In the elbow, where movement is of essential importance, excision had better be performed when the wound is large, although recovery with movement of the joint may take place without it in young adults. Under all circumstances the dislocation ought to be reduced, the question of excision or amputation turning upon the amount of mischief the soft parts or bones have sustained.

Compound dislocations and compound fractures into joints are clinically of very similar import.

When dislocation and fracture coexist, difficulties are often met with, but the reduction of the dislocation is often possible by manipulation aided by anæsthetics where without it is impossible, and I have reduced with its aid, in one case, the head of a fractured humerus from the subglenoid position, and in another a fore-arm displaced backward with fractured arm-bone, and afterward in each case adjusted the fracture with facility; I have likewise seen the head of the femur displaced upon the pubes pressed back into its socket, notwithstanding that a fracture of the shaft existed. I believe that in the majority of these cases the dislocation may be successfully treated before the fracture, the fractured bone being at the same time moderately extended. It may be prudent in some to apply splints before attempting the reduction of the dislocation, but such a step is not always necessary, or, indeed, advisable, for with the limb encased in splints the surgeon has less influence upon the dislocated bone. When the dislocation cannot be reduced, the fracture must be dealt with in the ordinary manner. In a case I recently had under care, of a woman æt. 66, in which the head of the femur was dislocated into the sciatic notch and an impacted fracture of the neck of the thigh-bone coexisted, a good limb was secured.

Separation of Epiphyses.

In all young patients, and in others under twenty, where a dislocation or fracture near a joint is said to be present, the surgeon should suspect the injury to be one of partial or complete separation, with or without fracture of an epiphysis, and particularly when any of the joints of the upper extremity are involved; for, whilst dislocation of the shoulder-joint in children is very rare, incomplete separation of the shaft of the humerus from its upper epiphysis is not seldom met with (Fig. 543), and by far the majority of cases of supposed dislocation at the elbow-joint in young subjects are examples of displacement of the lower epiphysis of the humerus together with the fore-arm bones. The same remarks are likewise applicable to the wrist-joint, dislocation of such in young people being almost if not quite unknown, whilst separation of the lower epiphysis is probably comparatively common. A pretty example of this kind is to be seen in Fig. 549.

In the lower extremity these cases are possibly rare. I have, however, seen several examples of displacement of the lower epiphysis of the femur with the tibia and fibula, and give an example of this accident in Figs. 521 and 585, and I believe that what are regarded as severe sprains of the ankle in children are often due to some displacement of one or other of the malleolar epiphyses, since I have seen many examples of arrest of growth in limbs that had been supposed to have been previously the seat of sprains.

I have, moreover, certainly seen two cases of displacement of the foot outward with the lower epiphysis of the tibia, one of which was compound, with the ends of the diaphysis presenting through the wound. It occurred in March 21, 1884, in a boy æt. 15, from the foot being caught between the spokes of a revolving wheel. The parts were readily restored to their normal position, and a good recovery ensued. The epiphysial cartilage in this case seemed to be attached to the diaphysis. How far arrest of growth in the bone will ensue time must prove.

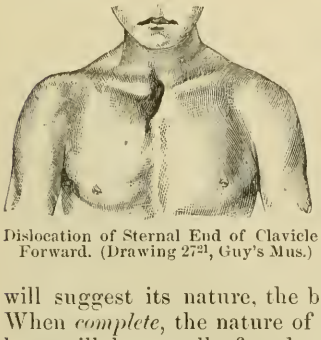
Again, there is good reason to believe that some examples of acute suppuration of joints following injury have been brought about by this cause, and that a partial or complete separation of an epiphysis in the hip, shoulder, elbow, wrist, or ankle-joint, associated with a tearing away of the periosteum from the diaphysis with which the epiphysis is associated, is occasionally followed by acute periosteal inflammation of the injured parts, complicated with suppuration of the contiguous joint, and not rarely with acute articular necrosis.

Dislocations of the Upper Extremity.

Dislocations of the spine and lower jaw have been considered in former chapters (pages 237 and 449). Those of the upper extremity will now occupy our attention.

Dislocations of the Clavicle.—Dislocations of this bone at its sternal end are rare accidents, though according to Flower they form about three per cent. of all dislocations of the upper extremity. They are produced by violence applied to the shoulder when the scapula is fixed, the clavicle being forcibly thrown toward the mesial line. Dislocation *downward* is an impossibility, the cartilage of the first rib preventing, but it may take place *forward*, *upward*, or *backward*, and may be partial or complete.

Fig. 485.



Dislocation of Sternal End of Clavicle Forward. (Drawing 27[21], Guy's Mus.)

Dislocation forward is usually caused by some violent pressure of the shoulder backward, although Melier (*Archives Gén. de Méd.*, tom. xix.) records a case in a child where it was produced by simply pulling the arm. The head of the bone in this accident forms a marked feature and cannot be mistaken for anything else (Fig. 485). When the dislocation is *partial*, some unusual prominence of the end of the bone, on comparing it with its fellow, will suggest its nature, the bone being only covered with skin and readily pressed back. When *complete*, the nature of the accident will be still better marked, and the end of the bone will be usually found pointing downward. Inflammatory thickening of the joint should not be mistaken for partial displacement.

Treatment.—There is usually little or no difficulty in reducing this form of dislocation by forcibly drawing back the shoulder and applying pressure to the displaced bone, though there is great difficulty in keeping the bone in its normal position; indeed, as a

rule, it is quite impossible to do this satisfactorily. In one case I succeeded by keeping the patient on his back in bed for three weeks with his arm bound to his side. A pad in the axilla, with a figure-of-8 bandage to keep the shoulder outward, the elbow being bound to the side, will do much toward the desired end, and a pad of lint applied outside the displaced end of the clavicle and firmly fixed in position by strapping carried over the shoulder and scapula has a very beneficial tendency. Nélaton advises the use of a common hernia truss. The surgeon, however, must expect a certain amount of failure in the treatment of these cases, though he may safely assure his patient that the usefulness of the arm will be but little, if at all, impaired. I have had one case of this dislocation combined with fracture of the sternal end of the bone, in which the dislocation was reduced by manipulation and the arm bandaged with a good result.

Dislocation upward is very rare. Malgaigne has recorded four such cases, Hamilton another, described by Dr. Rochester of Buffalo, and Dr. R. W. Smith a sixth (*Dublin Journal of Medical Science*, 1872). In 1865 such a case came under my care. It was in a young woman, a milliner, æt. 20, who two years before was violently crushed in a crowd, the violence causing pain which was referred to the upper part of her chest. She was treated at home and got well, although with a deformity, for which she consulted me. On examining her chest the sternal ends of both clavicles were felt above the upper border of the sternum, behind the sternal tendons of the sterno-mastoid muscles, and with the slightest pressure upon the shoulders the two ends could be made to meet. By drawing the shoulders backward the bones could be separated and pressed back into what appeared to be their normal position, but no appliance could keep them there. The patient had good movement in her arms and followed her occupation. I have the notes also of a second case that came under my care, in 1863, in which one bone was displaced; it occurred in a man æt. 35, and was produced by a fall on the shoulder.

In the Guy's Museum (1292[90]) there is a specimen of dislocation of the clavicle at its sternal end upward and forward. It was taken from a man æt. 40 who fell from a height and died nine days later from pneumonia.

Treatment.—In the treatment of this as of the last form of dislocation there is no difficulty in reducing it by drawing outward the shoulders and applying pressure upon the bone, but there is much in keeping the bone in position. The best means, however, are the application of a pad over the bone, the firm pressure of the scapula against the ribs by means of broad bands of strapping, and the supine position. Under all circumstances the surgeon may comfort the patient by the assurance that good and useful movement of the arm will be secured. *Overhand* movements, however, will always be difficult.

Dislocation backward stands next in point of rarity to that of dislocation upward, and is usually caused by violence, forcing the shoulder forward, or by direct force. I have seen but one such case, in a man æt. 52 who was crushed by falling bricks, and in it the dislocation was self-reduced on the second day, when the man was in bed.

The displaced clavicle so presses at times upon the trachea and œsophagus as to interfere with respiration and deglutition. In 1845 a sailor æt. 17 was admitted into Guy's with such an injury, the dislocation having been caused by a blow on the shoulder. It was easily reduced by drawing the shoulders back, and maintained *in sitû* without difficulty. Cases of this kind have been recorded by Mr. Brown of Callington (*Med. Gaz.*, 1845), and M. Pellieux, 1834 (*Revue Médicale*). In one singular case recorded by Sir A. Cooper the dislocation was produced by curvature of the spine, and Mr. Davie of Bungay excised the sternal end of the displaced bone to prevent death from suffocation. Mr. C. de Morgan has recorded a case in *Holmes's System* in which, in a girl æt. 10, the bone was thus displaced and successfully treated by means of a splint across the shoulder, with a pad between it and the spine, the shoulders being drawn to the splint by a bandage and the child kept in bed. The splint was removed at the end of a fortnight, and the articulation in four weeks became as firm as that on the other side; the arm, moreover, could be moved without causing any pain.

A separation of the sternal epiphysis of the clavicle may take place and be mistaken for dislocation. This can, however, occur only in young life. Mr. C. Heath brought forward an example of this kind in November, 1882, before the Clinical Society. It occurred in a boy æt. 14 who was bowling a cricket-ball when he felt something give way at his collar-bone. When seen, the inner end of the clavicle was unduly prominent and presented a sharp edge beneath the skin, between which and the suprasternal notch a thin lamella of bone could be felt, quite unlike the smooth end of the bone covered with cartilage. The bone fell into place on laying the patient down, and was kept *in sitû* by means of a plaster-of-Paris bandage.

Dislocation of the Scapula was formerly called "dislocation of the acromial end of the clavicle," but, as the clavicle is a fixed point, it seems only consistent with common sense, although not with custom, to follow Skey, Maclise, and Flower and call what have hitherto been described as *dislocations of the acromial end of the clavicle* dislocations of the scapula.

FIG. 486.

Dislocation of the Scapula Downward. (Mr. Poland's case.)

In the more usual form of this accident the acromion process of the scapula is forced *beneath* the clavicle. In rare cases it may be received *above* it. Both are commonly caused by direct violence to the shoulder.

SYMPTOMS.—The *symptoms* are well marked in both forms; the falling of the shoulder and projection upward of the acromial end of the clavicle in one (Fig. 486), and the projection upward of the acromion process of the scapula in the other, prevent any mistake being made.

TREATMENT.—In the dislocation of the scapula downward the aim of the surgeon is to raise the scapula with the arm and depress the clavicle, which is best done by drawing the elbow well backward and applying a pad over the clavicle, the pad and elbow being fixed in position by means of a belt or plaster-of-Paris bandage passed over the clavicle and round the elbow. The belt presses the clavicle downward and raises the shoulder and arm upward.

The parts fall into position at times when the patient assumes the horizontal posture; and when this is the case and the position can be maintained for two or three weeks, it is well to adopt it. At others a pad fixed over the clavicle by means of strapping or a bandage passed between the axilla will suffice, but the surgeon, recognizing the special wants of the case, must adapt his means to meet them in the best possible way. Good movements of the arm are, as a rule, acquired in time after either of these accidents.

Dislocations of the Humerus form at least half of all dislocations, and a sufficient explanation of this fact is to be found in the globular form of the head of the humerus, the shallowness of the glenoid cavity, the free movement of the articulation, and its liability to direct and indirect injury.

In 40 out of 60 consecutive cases, or in two-thirds of them, I found a direct blow upon the shoulder was the cause of the accident, while in the exceptional cases a fall upon the extended arm or elbow or a forcible dragging backward of the arm was the assigned cause. The accident is rare in childhood, although I have seen an instance of it at the age of thirteen, while Flower and Hulke have recorded a case in an infant fourteen days old. Two-thirds of the cases are found in men between fifty and seventy years of age, it being comparatively rare in women and in young adult life. I have, however, treated one in a man æt. 75.

Analysis of Sixty Consecutive Cases.

Out of 60 cases, 31 were described as *subglenoid*, or downward, 25 *subcoracoid*, or forward, and 4 *subspinous*, or backward; 49 were in males, and 11 in females. I am disposed to think that many of the cases called subglenoid were subcoracoid.

4	were in subjects	under		20	years of age.	
17	"	"	between	21	"	and 50.
38	"	"	"	51	"	" 70.
1	aged 75.					

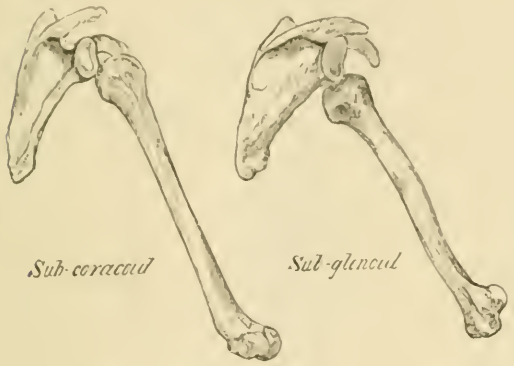
The head of the humerus may be dislocated—1. *Downward—subglenoid;* 2. *Forward—subcoracoid;* 3. *Backward—subspinous.*

When the coracoid process has been broken off, the head of the humerus may be displaced over the root of the former, two or three such cases being on record. The supracoracoid and *subclavicular* dislocations are very rare.

Subcoracoid.—This is without doubt the most common form of dislocation. Flower has shown (*Path. Soc.*, vol. xii.) that thirty-one out of the forty-one specimens of dislocation of the shoulder-joint found in the London museums belong to this class. In it the head of the humerus rests on the anterior lip of the glenoid cavity beneath the coracoid process, or even more forward, the completeness of this dislocation turning upon the amount of laceration of the attachment of the posterior scapular muscles. When they are completely torn through at their insertion into the great tuberosity of the humerus or

the tuberosity is torn off, the head of the bone will be more forward than when they are only stretched or partially divided. Many of the cases described by Sir A. Cooper as dislocation

Fig. 487.



From Mr. Flower's Models, Middlesex Hosp. Mus.

Fig. 488

Subcoracoid Dislocation of Head of Humerus. (Drawing 274.)

downward or as partial dislocation were doubtless of this kind, and many others recorded as examples of subclavicular are nothing more than specimens of this variety (Fig. 487).

Symptoms.—The symptoms of this form of dislocation, in their general character, are the same as in most others, such as inability to move the arm, immobility, and pain often passing down some nerve-trunk and aggravated by movement. On looking at the part and comparing the injured with the sound side before swelling has appeared, some striking points will be observed, such as flattening of the deltoid, prominence of the acromion, and a depression beneath it. Extra prominence will also be seen below the coracoid process, from the head of the bone pushing forward the pectoral muscle (Fig. 488); from behind, too, there will be some flattening of the shoulder. There will be little or no lengthening of the limb, but the elbow will be found projecting more or less from the side; the movements of the fore-arm will be perfect. On manipulating the shoulder the head of the bone will be felt beneath the pectoral muscle in front of the scapula, and from the elbow it will be made to move.

Dislocation downward, or subglenoid, although usually given as the most common, is probably second in frequency to the subcoracoid just described. Flower asserts that not one in ten of all dislocations of the humerus can properly be called subglenoid. In it the head of the bone rests below the glenoid fossa (Fig. 487), the rent in the capsule being at its inferior instead of its anterior border, and the soft parts mechanically interfering with the natural tendency of the deltoid, coraco-brachialis, and biceps to draw the head of the humerus upward toward the coracoid process.

Symptoms.—The most constant are immobility of the arm, as well as inability to move it without pain, with a greater separation of the elbow from the side, a more marked flattening of the shoulder, greater depression beneath and extra prominence of the acromion than are met with in the subcoracoid variety. The most typical, however, are a depression of the anterior fold of the axilla, from a drawing down of its attachment; a falling of the breast, as indicated by a lower position of the nipple; the marked presence of the head of the bone in the axilla; the separation of the coracoid process and the head of the malplaced bone by a space of one to two inches (Fig. 489); and a clear elongation of the arm for one and a half inches.

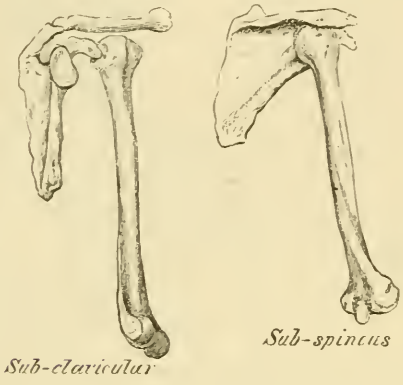
Fig. 489.

Subglenoid Dislocation of Sixteen Weeks' standing. Taken from a man æt. 56, showing depression of the anterior fold of the axilla, falling of the breast, and elongation of arm.)

Hulke describes (*Holmes's System*, vol. i. 3d ed. p. 978) two rare examples of a variety of subglenoid dislocation which he saw in the practice of the late Sir W. Fergusson. In both the arm was strongly *abducted and raised*, the elevation being so great as to make one patient seek support of the arm by grasping the end of a stick raised above his vertex, whilst the other rested his hand on the top of his head. In neither could reduction be effected.

Dislocation Backward, or Subspinous.—This is next in rarity to the last, and in it the head of the bone rests beneath the spine of the scapula or base of the acromion (Fig. 490); the latter position being a less complete luxation than the former,

Fig. 490.



From Flower's Models, Middlesex Hospital.

Fig. 491.

Subspinous Dislocation of Head of Humerus. (Taken from life.)

and more common. It corresponds to Malgaigne's "subacromial" variety, this completeness of the dislocation depending upon the amount of laceration of the muscles attached to the bone, and more particularly of the subscapularis.

Symptoms.—The symptoms of this accident are very marked. Looking at the shoulder in front, there will be the flattening of the deltoid and prominence of the acromion as usual, but there will be a marked flattening, if not depression, of the soft parts below the coracoid and acromion processes. The elbow, instead of being fixed away from the side, will be drawn to it and forward, the fore-arm generally pointing outward. The back view, however, is the most typical, the head of the bone covered with muscles and soft parts forming a prominent feature in the case (Fig. 491). I had under observation a patient about thirty years of age who could at will dislocate her shoulder in this direction by muscular action. In this dislocation the limb is said to be slightly longer than normal, but I have not found it so.

Subclavicular Dislocations, in which the head of the humerus rests below the clavicle on the sternal side of the coracoid process, are exceedingly rare (Fig. 490). I have never seen a complete example. Malgaigne informs us that in it the arm is pressed against the chest with the elbow slightly removed from the side, the head of the bone being felt and seen in its abnormal position and the shaft instead of the head of the humerus felt in the axilla. The bulk of cases recorded as of the subclavicular kind are probably subcoracoid.

The **supracoracoid** dislocation is a mixed form of accident, as it is secondary to a fracture of the coracoid process. Malgaigne has recorded an example, and Holmes, in the *Med.-Chir. Trans.*, vol. xli., a second, with an account of the dissection of the case, the preparation being in St. George's Museum. He also describes a third, which occurred in the practice of Sir P. Hewett.

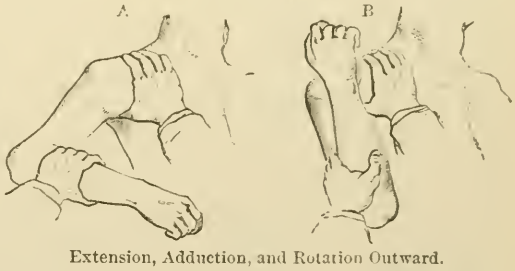
Some points in diagnosis remain to be told, and the most important was pointed out by the late Mr. T. Callaway in his excellent Jacksonian prize essay for 1849, which is "*that in taking the vertical circumference of any shoulder in which dislocation exists by means of a tape carried over the acromion and under the axilla an increase of about two inches over the sound side is an invariable concomitant.*" He should have added, however, that this test is applicable only to recent cases, and not to such as show muscular atrophy. The same author also shows how elongation of the limb does not take place—at any rate, to any extent—the different accounts given by authors on this point depending upon the fact that they are content with optical rather than actual measurement. Professor Dugas of Georgia has also pointed out (*Southern Med. and Surg. Journal*, 1856) a sign of dislocation of the shoulder-joint that merits more notice than it has received, and I am indebted to Dr. W. Briggs of Nashville for calling my attention to it. It is based upon the physical fact *that, in consequence of the rotundity of the thoracic walls, it is impossible for*

both ends of the humerus to touch them at the same time. "If the fingers, therefore, of the injured limb can be placed by the patient or by the surgeon upon the sound shoulder while the elbow touches the thorax—a condition that obtains in the normal condition of the joint—there can be no dislocation. And if this cannot be done, there *must* be one; for no other injury than a dislocation can induce this physical impossibility." Dr. F. Hamilton has likewise shown (*Lond. Med. Rec.*, April, 1875) how in a dislocation a rule will touch at the same time the acromion process and the elbow of the injured side—a condition that cannot exist in health.

It sometimes happens that the head of the bone after its apparent reduction fails to remain in position and falls out again; and when this occurs, it becomes a question whether some part of the glenoid cavity is fractured or some other fracture exists. I have recently seen a case of dislocation of the head of the humerus forward and downward in which a portion of the glenoid cavity was broken off and displaced downward, associated with severe injury to the radio-spiral nerve. In children, or young persons under twenty-one, the upper epiphysis of the humerus may be separated, or, rather, the shaft of the humerus may be displaced off the epiphysis, which retains its normal position, and under these circumstances the arm should be most carefully manipulated under chloroform, to make the diagnosis sure. In exceptional cases, however, this slipping out again is not to be explained by these complications, for in the case of a man æt. 75 who had a dislocation backward the head of the bone could not be kept in position till the muscles began to act after the effects of the chloroform had subsided, and I had to hold the bone in place till the patient recovered and the muscles acted naturally.

Treatment.—The use of anæsthetics has completely revolutionized the treatment of dislocations, and at the present day nothing can usually be simpler than the reduction of a dislocation of the shoulder, and what was formerly called reduction by *stratagem* is now the rule. "If you can get a person off his guard," wrote Abernethy, "you have first to put your hand up to the head of the bone, depress the elbow, and it will sometimes succeed in putting it in;" and the modern surgeon, in describing the reduction of dislocations by *manipulation*, might use the same language. To reduce a dislocated humerus by *manipulation* an anæsthetic is essential; and when the patient is *fully* under its influence, as well as in the horizontal position, the surgeon should grasp the shoulder with one hand and the flexed elbow with the other (Fig. 492, A). When the dislocation is subglenoid or subcoracoid, the thumb of the surgeon may be placed over the head of the bone and the fingers over the spine of the scapula, the thumb acting as a fulcrum; with the other hand the flexed elbow should be drawn from the side and extension made, some slight rotatory movement outward being employed. When extension has been carried to its full extent, the elbow should then be raised and the arm made to describe a semicircle in the direction of the sternum and the face, and then suddenly brought down to the side of the thorax, the head of the humerus at the same time being rotated inward. The thumb of the opposite hand should give the right direction to the head of the bone (Fig. 492, B). Should the first attempt fail, a second may succeed, or possibly a third. In the majority of dislocations of the shoulder this method will succeed. In Philadelphia this practice is known as H. Smith's method. In the dislocation backward, or subspinous, the same method will suffice, but in that case the head of the bone, being behind the glenoid cavity, requires pushing forward. Under such circumstances the surgeon should stand slightly behind the patient, with one hand grasping the axilla, with the thumb behind, and with the other the elbow, making extension; reduction may then be effected by drawing the elbow backward and rotating the bone. By these means I easily reduced an interesting case of dislocation backward (subspinous) complicated with fracture of the ribs of the same side and of the opposite clavicle. When these means fail or when chloroform is not at hand, reduction by means of extension with the heel in the axilla should be employed, the surgeon with his unbooted heel pressing upon the head of the humerus or lower border of the axilla, and with his hand grasping the fore-arm of the misplaced limb and making steady extension: some slight rotatory movement often facilitates reduction. The head of the bone usually slips into

Fig. 492.



Extension, Adduction, and Rotation Outward.

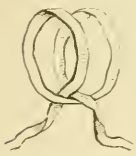
its place with a perceptible jerk, and the moment this is felt all extension should be stopped.

To facilitate extension the clove-hitch (Fig. 493) may be employed, and instead of the heel Mr. Skey's well-padded iron knob.

Mr. W. F. Teevan informs me that he has known the third rib to be fractured in the attempt to reduce a dislocation of the head of the humerus with the foot in the axilla.

If the humerus still resists, the following plan, writes Hulke (*Holmes's Surgery*, vol. i., 3d ed.), "which I have never known to fail in a recent dislocation, may be tried. The patient is seated in a high chair, which is placed about two feet from the post of an open doorway; the surgeon, having his back against the door-post, places one foot upon the side of the chair and with his knee presses into the axilla, and, with both hands upon the shoulder, steadies the patient's body; a jack-towel is then fixed by a clove-hitch knot to the patient's arm, just above the elbow, and by its means two or three assistants, placed on the other side of the doorway, make steady extension horizontally outward."

Fig. 493.



Clove-Hitch.

This is only a modification of Sir A. Cooper's plan of bending the extended arm over the knee, placed in the axilla with the patient sitting, using the humerus as a lever, and is doubtless a good one.

In 1870, Kocher of Bern (*Berlin Klin. Woch.*, No. 9, 1870) introduced the following new and simple method of reducing subcoracoid dislocations, which has been much and successfully practised at Guy's:

With the patient sitting, the surgeon grasps the elbow of the affected limb with the fore-arm flexed at a right angle, presses it firmly to the side of the patient's chest, and rotates the flexed fore-arm and arm outward as far as they will go—that is, until firm resistance is experienced. He then, with the arm still rotated outward, carries the elbow forward and inward over, but away from, the chest, toward the median line of the body, and suddenly rotates the arm inward, carrying the hand of the affected limb by this movement toward the sound shoulder. By this last movement the head of the bone is replaced in the glenoid cavity.

Mr. J. E. Kelly of Dublin also recommends a method of reduction which in his and his colleagues' hands has proved successful in twenty-seven cases. In it the patient should be placed on his back at the edge of a couch, lower by three inches than the great trochanter of the operator. "The operator places the injured arm at right angles to the body, and, standing against it with his side to the patient and his hip pressed firmly, but not roughly, into the axilla, he folds the arm and hand of the patient closely round his pelvis and fixes the hand firmly by pressing it against the crest of his ilium. The second step, during which the reduction is affected, is very simple, consisting merely of a rotation or version of the surgeon's body outward away from the patient with a force and rapidity which necessarily vary with the peculiarity of the dislocation, some yielding most readily to a sudden and powerful effort, and others to gentle and gradually increasing traction" (*Dublin Journal of Med. Soc.*, September, 1882).

Fig. 494.

Reduction by Extension of Arm Upward.

Should these means fail, success may be secured by drawing the arm vertically upward, as practised by White of Manchester in 1764, and recently advocated by Mr. Lowe of Burton-on-Trent (*St. Barth. Rep.*, 1870). In 1864 I succeeded by these means in the case of a subglenoid dislocation of one month's standing in a man æt. 64, the method of manipulation and extension having failed, and again, more recently, in a similar case of twenty-four hours' standing, in a gentleman æt. 30, when every other means had proved unsuccessful (Fig. 494). Mr. Lowe places his patient in a sitting posture on the floor and then stands behind him on a sofa, forcibly extending the dislocated arm upward, the scapula being kept fixed by the surgeon's foot. In all cases the extension should be gradual and steady, the counter-extension effective; no jerking or great force should be allowed; pulleys are to be looked upon as dangerous appliances: with the use of anæsthetics they should be abandoned. In recent dislocations they are never needed, and in the old adhesions should be broken through by forcible rotation and flexion of a joint rather than by extension.

Extension forward is at times beneficial. It proved successful in my hands in a case of subspinous dislocation of three weeks' standing in a man æt. 75.

In a neglected dislocation of twenty-five days' standing Mr. Cock succeeded in 1859 (*vide* author *On Diseases and Injuries of Joints*, 1859) by the following plan, all other means having failed: "An air-pad made of vulcanized india-rubber was placed in the axilla and the arm firmly bandaged to the side, the air-pad thus being made to exert a powerful outward pressure upon the head of the bone. Upon removing the bandage upon the third day the head of the bone was found to have returned to its natural position."

Without anæsthetics obstacles to the reduction of a dislocation of the shoulder are muscular spasm and the difficulty of replacing the head of the bone through the rent in its capsular ligament; with them, the resistance of the muscles is an element which has not to be considered, the second one alone existing. In old dislocations the presence of adhesions is an extra element of difficulty.

After-Treatment.—After the reduction of a dislocation the arm should be bound to the side for a week and kept at rest for a fortnight or more, with the object of giving time for the lacerated or injured parts to repair and recover their power. All violent exertion should be forbidden, and nothing more than passive motion should be sanctioned for several months.

It happens at times that the trunks of the nerves are so injured as to give rise to paralysis of the muscles supplied by them. I have seen, in one case, the parts supplied by the ulnar nerve permanently paralyzed, and in another those supplied by the musculo-spiral. It is by no means uncommon to find the circumflex nerve so injured as to be followed by a most complete wasting of the deltoid muscle. In many cases, however, in which paralysis follows dislocation, recovery may ensue; and in a very marked example I saw in 1874, in which paralysis of all the parts supplied by the radio-spiral nerve was most complete, recovery took place in fifteen months.

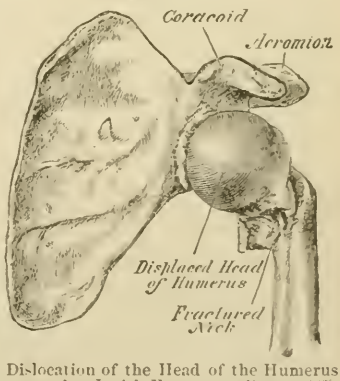
In neglected dislocation of the shoulder it is always a difficult question to decide as to the expediency of attempting reduction. Sir A. Cooper used to say that after twelve weeks' rest an attempt should not be made, and in a certain sense such an opinion is correct; but there are many cases of less standing in which the attempt would be wrong, and some few of much longer standing in which it would be right.

Where good movement exists after twelve weeks there is little need for the attempt, unless under exceptional conditions. When bad movement exists, or none at all, the attempt may be made; for cases are on record in which reduction has been effected after a year or more.

Fracture and Dislocation of the Head of the Humerus.—Dislocation of the head of the humerus is sometimes associated with fracture of the neck of the bone. It is, as a rule, caused by a direct fall or blow upon the shoulder, and it is probable that the dislocation occurs first and the fracture follows. I have seen two undoubted examples of the injury. In one, a boy æt. 16, the head of the bone was dislocated backward beneath the spine of the scapula, and in the second, a man, beneath the coracoid process. When the dislocation can be reduced at once, as it may by means of an anæsthetic, so much the better. When it cannot, the fracture must be treated and the dislocation left alone, good movement at times being the result. In Fig. 495 such a complication existed. The preparation was taken from a gentleman æt. 64, three months after the injury, before union had taken place at the seat of fracture.

It must be remembered that cases of fracture of the humerus about its tuberosities, when united, often simulate those of dislocation.

Fig. 495.



Dislocation of the Head of the Humerus associated with Fracture. (Prep. 1114[3], Guy's Hosp. Mus.)

Compound dislocations of the shoulder are grave accidents; and when the soft parts have been much injured, the best plan is probably to resect the head of the bone, although, when the wound is limited or clean and reduction easy, it may be right to treat the case as one of wounded joint.

Dislocation of the Elbow.—This accident is most common in early life, and according to the Middlesex Hospital table (*Holmes's Syst.*, vol. i.) more than half the cases occurred in boys between the ages of five and fifteen. Out of 33 cases, Dr. Hamilton found 19 in children under fourteen years of age. At Guy's these proportions are

not quite so large; for out of 13 cases, 6 were in subjects between ten and twenty, 3 between twenty and thirty, 3 between thirty and forty, and 1 between forty and fifty. In only one case was the subject a woman.

Both bones may be displaced backward, outward, inward, or forward, backward and outward, or backward and inward. The *ulna* may be displaced backward alone, the radius maintaining its natural position, and the head of the *radius* may be thrown forward or backward.

These dislocations may be more or less complete, simple or compound, uncomplicated, or complicated with fracture of one or more of the bones entering into the formation of the joint, or with fracture or displacement of an epiphysis.

In point of frequency dislocation of both bones backward is the most common, the other dislocations of both bones occurring in the order above given, dislocation forward being so rare that without a fracture its existence was doubted by Sir A. Cooper; but Velpeau and Canton have each recorded undoubted examples.

The force required to produce any one of these injuries is severe. It is generally exerted directly upon the elbow or indirectly upon the hand, by either a fall or a twist. To admit of any dislocation, there must of necessity be much laceration of the ligaments.

Symptoms and Diagnosis.—These accidents are not difficult to diagnose when they are seen at an early period of their existence, though after the lapse of some hours great difficulty may be experienced, owing to the swelling masking the points of bone and rendering it difficult to make out their relative positions.

The injured joint should always be carefully examined, each point of bone felt for, and its relative position with other points compared with those of the sound limb. In no cases can the surgeon derive greater assistance or feel more forcibly the value of this rule than in dislocations of the elbow. The student should accustom himself to the manipulation of healthy joints and learn where to place his finger upon the different prominences and depressions, and, having learned the normal conditions, he will usually find but little difficulty in discovering when a displacement has occurred.

When both bones are dislocated *backward* (Fig. 496), the forearm is partially flexed and the hand slightly pronated; the displaced bones project backward and make a prominent swelling with the tendon of the triceps, while the condyles of the humerus can readily be felt in front, pushing the artery and soft parts forward, the inner condyle of the humerus and the olecranon being far apart, and the great increase in the antero-posterior diameter of the joint seen at a glance. In thin subjects the olecranon and the head of the radius can readily be felt in their abnormal position to one another, and the head of the latter bone made through the hand to rotate in its new situation.

Fig. 496.

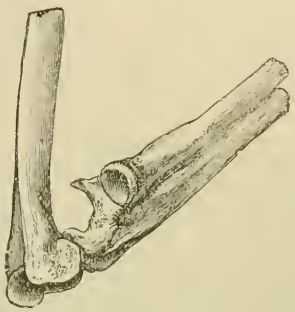
Dislocation of Radius and Ulna Backward. (From Sir A. Cooper.)

In the dislocation of the bones *outward* the marked prominence of the inner condyle of the humerus as seen from behind is a typical feature (Fig. 497), and with luxation of the same bones inward the external condyle is equally prominent.

Fig. 497.

Dislocation of the Right Radius and Ulna Outward (Posterior View.)

Fig. 498.



Dislocation of Radius and Ulna Forward. (Canton's case, *Dub. Quart.*, August, 1860.)

In the rare form of dislocation *forward* (Fig. 498) the loss of the olecranon from its right position, the unusual prominence of the condyles of the humerus, and the marked elongation of the fore-arm are the chief features.

In dislocation of the *ulna backward* the pronation and twisting inward of the hand, the great shortening of the ulnar side of the fore-arm, and projection backward of the olecranon mark the nature of the accident.

When the *head of the radius* is displaced alone forward (Fig. 499) or backward, its absence from its natural position, as well

as its presence in an unnatural one, can usually be made out. In the forward dislocation the flexion of the joint is limited.

In the backward (Fig. 500) the movements may be complete; more commonly, however, they are limited.

Fig. 499.

Dislocation of the Radius Forward. (Drawing 278, Guy's Hospital. From dissection. Mr. Hilton's case.)

Fig. 500.

Dislocation of the Head of the Radius Backward.

Treatment.—When the nature of the dislocation has been once recognized, there is little difficulty in its treatment; for, with the patient anæsthetized, and the muscles consequently paralyzed, the reduction of any dislocation of the elbow by *manipulation*, or rather by moulding the joint into its right form, is readily effected. This may usually be done by the surgeon's hands, pressure being applied according to the wants of the individual case, guided by the known anatomy of the part. Occasionally extension of the fore-arm is required, or the forcible bending of the fore-arm over the surgeon's knee or thumb; but in the majority of early cases the joint may be moulded into its normal position.

Mr. J. E. Kelly of Dublin (*Dublin Journ. of Med. Sci.*, July, 1883) describes a method of reduction in dislocations at the elbow-joint worthy of consideration, in which the surgeon, sitting on a table, fixes the patient's humerus beneath one thigh and extends with his hands the fore-arm raised between them.

When some weeks have been allowed to pass without reduction, considerable force may be required to break down the adhesions, forcible flexion and extension being then applicable.

Up to two months any dislocation of the elbow may be reduced, or rather an attempt at reduction may be made. After that date, when useful movement has become possible, the attempt had better not be entertained. When no movement exists, it is, however, justifiable, but no definite rule can be laid down on this point, since each case must be judged upon its own merits. I have reduced, after nine weeks, a dislocation of the bones of the fore-arm backward with an excellent result, and have failed after five. What would be justifiable under some circumstances would be unjustifiable in others, the age of the patient, his position or occupation, and his necessities having as great an influence in guiding the surgeon as the time that has elapsed after the accident and the amount of useful movement in the joint.

When both bones are displaced, or the ulna alone, the surgeon should grasp the fore-arm as a whole. When the radius is the bone displaced, the extending force should be applied from the hand.

After-Treatment.—After the reduction of the dislocation the arm should be kept in a splint and cold lotion or ice applied, according to the amount of inflammation that ensues. When little inflammation follows, passive movement may be allowed in about ten days or a fortnight. After the reduction of a dislocation of the head of the radius forward there is usually great difficulty experienced in keeping the bone in its position. To effect this I have found the forced flexion of the fore-arm the best, the wrist and fore-arm being bound to the arm by means of a bandage. In a recent case the benefit of this practice was well displayed.

When reduction of a neglected dislocation has been effected, it is wise to fix the elbow on an angular splint for ten days or a fortnight and to apply cold water, and after all inflammatory action has subsided to allow of passive or, possibly, forcible movements, as a stiff elbow-joint is a misfortune of no mean importance, and to prevent it measures may be employed which under other circumstances might be considered rash. In neglected cases, where reduction is beyond all hope, the surgeon may use a considerable amount of force to flex the fore-arm to a right angle, in which position it should be fixed.

In *compound dislocation* of the elbow-joint, where reduction is possible and the wound

small, the case may be treated as one of wounded joint—viz. by splints and the application of ice—good hopes existing of a sound recovery being secured with movement. When the wound is large and the soft parts are materially injured, excision of the joint should be performed, the success attending this practice generally being very satisfactory. When the vessels and nerves are clearly so injured as to preclude the possibility of a useful limb being secured, amputation may be required.

Fig. 501.

Displacement of the Lower Epiphysis of the Humerus Backward. (Hutchinson's case.)

In all these dislocations of the elbow the surgeon should be careful to ascertain that they are uncomplicated, that no fracture coexists, or—what is more common in young subjects—that no displacement of the lower epiphysis of the humerus is present, such as is shown in Fig. 501. This can be made out only by a careful comparison of the sound and injured sides and the appreciation of the crepitus of fracture, the crackling of effusion, and the semi-crepitating feel of a displaced epiphysis.

In June, 1881, I had under my care at Guy's a boy æt. 9 in whom the lower epiphysis of the humerus, with the bones of the fore-arm, was displaced backward, and in which the anterior border of the diaphysis so injured the brachial artery as to occlude it. The displaced bones were restored to their position and the arm was bound with splints. The case did well, and in six weeks there was good movement in the joint and pulsation had returned in the radial, though not in the brachial, artery.

Dislocations of the Wrist.—These are exceedingly rare accidents, the majority of recorded cases of this nature being fractures of the lower end of the radius. What is known as "Colles's fracture" is the more common form of accident. Dupuytren pointed this out years ago, and the truth of the observation is now fairly recognized. When dislocation does occur, the hand is displaced either *forward* or *backward*, the ends of the radius and ulna forming prominent points in the opposite positions and the styloid processes of the radius and ulna being recognizable points in a line with the shafts of the bones of the fore-arm (Fig. 502). This feature is important; for when the displacement of the hand is due to a fracture of the lower ends of the radius and the ulna, the styloid processes will be in connection with the hand instead of with the shafts of the bones.

Treatment.—Reduction by manipulation is readily performed, extension of the hand and direct pressure upon the displaced bones, as a rule, effecting the surgeon's purpose. The parts should be kept in position by an anterior and a posterior splint extending to the flexure of the fingers. The splints should be removed, however, as soon as the parts have become firm—that is, in about three weeks—and passive movement of the fingers should be enforced.

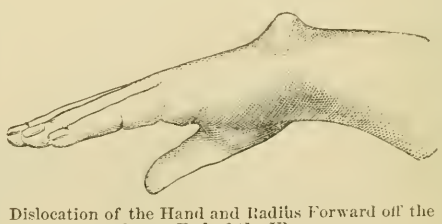
Dislocation of the lower end of the radius with the hand may take place whenever the hand is forcibly pronated or supinated. When forcibly pronated, the ulna projects backward and the radius and hand forward; when supinated, the reverse conditions are found to exist.

I have seen the former accident but once, and that case is here figured (Fig. 503). It was in a woman æt. 56 who was admitted into my ward at Guy's for another affection. The dislocation had taken place some months previously and had never been reduced. It

Fig. 502.

Dislocation of the Hand Forward. (Taken from a cast of Mr. Cadge's, copied from Erichsen's work.)

Fig. 503.



Dislocation of the Hand and Radius Forward off the Lower End of the Ulna.

was the result of a fall upon the dorsum of the hand. Pronation and supination of the hand were limited, and the ulna was fixed in its new position. The hand, although more pronated than natural, was very useful.

Such dislocations are readily reduced by extending the hand and employing pressure to the displaced bones. After their reduction anterior and posterior splints should be applied for two or three weeks, to prevent the bones slipping out of position and to allow the ligaments time to unite. In the case figured no treatment was available.

Dislocation of the carpal bones is an occasional though rare accident, and the displacement of the *os magnum* backward, from a fall upon the flexed hand, is the most frequent form. I have known this to occur in a woman during the efforts of parturition in grasping a towel and forcibly bending the wrists, the bone being pressed out of its connection. When the accident occurs, the prominent head of the bone on the dorsum of the wrist in a line with the metacarpal bone of the middle finger is too marked a feature to allow of there being any difficulty in the diagnosis. The bone, as a rule, is easily reduced by pressure and kept in position by means of a pad. This pad must be maintained in position for many weeks after the accident, to allow time for the ligaments to consolidate.

South, in a note to his translation of Chelius, records a case in which the *pisiform bone* was displaced, while Fergusson and Erichsen describe others caused by overaction of the flexor carpi ulnaris. Erichsen also mentions a dislocation backward of the *semilunar bone*, and in St. George's Hospital Museum there is a specimen of compound dislocation of this bone on both sides, occasioned by a fall from a height upon the hands, in which the bones were pressed out of a wound in front of the wrist.

Maisonneuve has recorded (*Mém. de la Soc. de Chir.*, tome ii.) a case in which the second row of carpal bones was displaced backward from the first, and Erichsen another, in which the metacarpal bones were displaced backward from the carpus. These accidents are very rare.

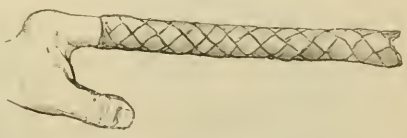
Dislocation of the thumb at any of its joints is not unusual. The *metacarpal bone* may be displaced backward or forward from the trapezium, the former being the more common accident. This dislocation is frequently complicated with an oblique fracture through the base of the metacarpal bone. Sir A. Cooper described a dislocation inward, but gave no case. Dr. F. Hamilton questions its occurrence.

Reduction of these dislocations by extension and local pressure is usually readily effected, the bones being kept in position by means of a pad and a good splint extending some inches above and below the displaced bone.

Dislocation of the first phalanx from the metacarpal bone is a recognized accident, the displacement *backward* being the usual form. Dislocation *forward* is a rare one. The first form is usually the result of a fall upon the distal end and palmar surface of the thumb, the head of the metacarpal bone projecting forward, the base of the first phalanx backward, and the extreme phalanx being flexed upon the first. The head of the metacarpal bone in some cases may be thrust forward through the capsule of the joint and caught between the two heads of the flexor brevis muscle, whilst in others, as in one I have seen—which was compound—the long extensor tendon of the thumb was hitched round the ulnar side of the base of the first phalanx, and thus prevented reduction, which was readily effected by forcible extension, adduction, and rotation.

TREATMENT.—In some cases the reduction of this form of dislocation is effected with ease by simple extension or by the pressure of the surgeon's thumb upon the displaced phalanx, and for the purpose of extension nothing equals in value the Indian toy called a "puzzle," or tube of plaited reed (Fig. 504). When this is not at hand, strips of strapping applied longitudinally to the distal digit and fixed by a circular piece will answer the purpose. In some instances all these means fail and there is yet much obscurity as to the cause of the difficulty. The numerous muscles and tendons that surround the joint doubtless have a powerful influence, more particularly the two heads of the short flexor with the sesamoid bones; and when the wound in the capsule is small, these muscles act more powerfully, the base of the displaced bone or the head of the metacarpal bone being held by these parts "as a button is fastened into a button-hole." Under these circumstances success may at times be achieved by flexing the metacarpal bone of the thumb to an extreme degree, rotating, and then suddenly extending the displaced phalanges, this manœuvre, as it were, freeing the displaced bone from the many tendons and ligaments that surround the joint, and that doubtless at times interfere with its reduction. I succeeded by this method in one case where every other had failed. My friend the late Mr. Sells of Guildford informed

FIG. 504.

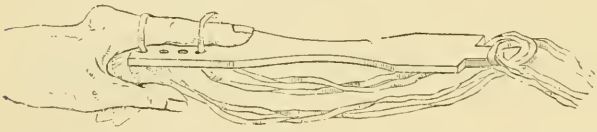


me that he had with facility reduced several dislocations of this form by forcibly bending the thumb back, so as to tilt the base of the phalanx over the head of the flexed metacarpal bone, and then extending it. Both these means have the effect of relaxing the short flexor muscle, as pointed out by Prof. Fabbri. When all such means as have been mentioned have been unsuccessfully tried, the subcutaneous division of the tendons and ligaments that appear to prevent reduction has been practised with variable success; and when this fails, excision of the part has been employed. In a case of this kind of six months' standing, where the thumb was a useless member and the seat of pain, I excised the joint with excellent success, a movable articulation being secured, with hardly any deformity.

When the bone is displaced *forward*, it seems probable, from the dissections of M. L. H. Farabeuf (*Arch. Générales de Médecine*, September, 1876), that the extensor tendons of the thumb being stretched on the inner or outer side of the metacarpal bone is the cause of the difficulty in its reduction, and under such circumstances forced flexion of the thumb upon the palm, aided by manipulation, is generally enough to replace it.

Dislocation of the ungual phalanx of the thumb may take place in either direction, forward or backward, the last being the more common; and, the displaced bone being so small, difficulty is often felt in applying extension to it. The puzzle (Fig. 504) is the best thing to employ for the purpose, or Levis's apparatus (Fig. 505). At times pressure with the thumb upon the displaced bone or forcible flexion will succeed. Hamilton pithily advises "forced dorsal flexion in the case of the backward luxation, and forced palmar flexion in the case of the forward dislocation" (3d ed., p. 634).

Fig. 505.



Dislocations of the phalanges of the fingers, like those of the thumb, may occur in two directions, the backward being the more common. They are readily made out, and are easily reduced by extension or by flexion and then extension.

Dislocations of the Lower Extremities.

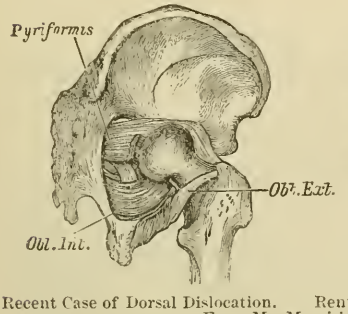
Dislocations of the Hip.—These are grave accidents, and are found mostly in male adults between fifteen and fifty years of age, but occasionally in the young or the old.

The following analysis shows many of these points:

Out of 80 consecutive cases which have occurred at Guy's and in my own practice, 18 occurred in subjects under twenty years of age, the youngest being five; 36 between the ages of twenty-one and forty, and 26 had passed that period; 69 were males, and 11 females; 41 were on the dorsum, 14 into the foramen ovale, 16 into the sciatic notch, and 9 on the os pubis.

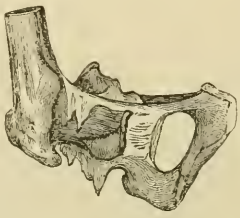
Mr. Powdrell (*Lancet*, 1868) has recorded a case in which the head of the femur was displaced into the foramen ovale at the age of six months; it was reduced by manipulation. Erichsen has recorded another, of dislocation on the pubes, in a child a year and a half old. I have treated three cases of dislocation on the dorsum in boys æt. 5 and in a girl æt. 5½, but these are exceptions. On the other hand, dislocations may occur in the aged. Malgaigne has recorded five between the ages of sixty and eighty-five, and my notes contain cases which occurred in men aged sixty-one, sixty-four, sixty-five, and seventy-six; but at this time of life fracture of the neck of the femur is more common.

Fig. 506.



Recent Case of Dorsal Dislocation. (From Mr. Morris's paper.)

Fig. 507.



Rent in Capsule, with Femur Flexed.

The accident is always the result of violence, no slight force being required to tear

through the ligaments that hold and bind the head of the femur in its deep pelvic cup; indeed, were it not for the great leverage of the lower extremity, the accident would probably be a rarity. In exceptional instances, however, the bone is displaced with the slightest force. I have had under my care a young man whose femur had been dislocated a dozen times or more, the smallest twist in the limb causing its dislocation backward.

Congenital dislocations and displacements from disease are not included in this group.

Dislocations from accident are of various forms, but the division made by Sir A Cooper is doubtless practically the best, if we remember that varieties of each form or partial dislocations are met with in practice, since there is good reason to believe that the head of the thigh-bone may rest at any point round its socket.

1. Dislocation *upward* and *backward* on the dorsum ilii is the most common.

2. Dislocation *backward*, toward the ischiatic or sciatic notch—a variety of the latter—stands third on the list as to frequency.

3. Dislocation *downward* and *inward* into the foramen ovale stands second.

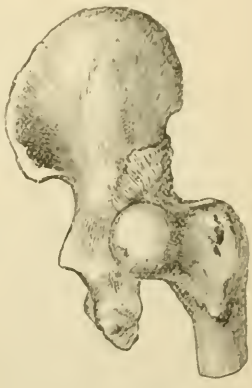
4. Dislocation *upward* and *forward* upon the pubes is about equal in frequency to that toward the sciatic notch.

These several forms of dislocation depend much upon the degree of flexion or extension and of inward or outward rotation of the thigh at the time of luxation. The head of the femur under most, if not all, circumstances, as demonstrated by Mr. Henry Morris in an able paper (*Med.-Chir. Trans.*, 1877), leaves the acetabulum, when the lower extremity is *ab*ducted, through a rent in the capsular ligament where it is the thinnest —viz., at the inner and lower side of the joint (Fig. 507), the strong ilio- and ischio-femoral ligaments situated on the anterior, outer, and posterior aspects of the joint and the shape of the acetabulum preventing displacement in any other position. With the limb abducted, however, the head of the femur is more than half out of the acetabulum, the ligamentum teres is quite loose, and all the strong portion of the capsule is relaxed. Indeed, Mr. Morris believes that it is only in *abduction* of the lower extremity that a simple dislocation of the head of the femur can possibly occur, and that a dislocation on to the dorsum ilii or toward the sciatic notch is due to the amount of *flexion* and rotation of the limb *inward* at the moment of the accident, and dislocation on to the pubes to *extension* and rotation *outward*; also that the degree of *flexion* and rotation of the limb *inward* determines in any particular instance whether the dislocation shall be dorsal or ischiatic, the latter variety occurring when flexion is carried to an extreme.

Fig. 508.

Dislocation of the Head of the Femur on Dorsum Backward and Upward.

Fig. 509.



Dislocation of the Head of the Femur Backward.

Taken from specimens in the Middlesex Hospital Museum, and prepared by Mr. Morris.

Direct dorsal dislocation can be produced only by immense violence, and is often complicated with fracture of the acetabulum.

In all cases the round ligament and capsule are torn across, the muscles about the joint being more or less lacerated.

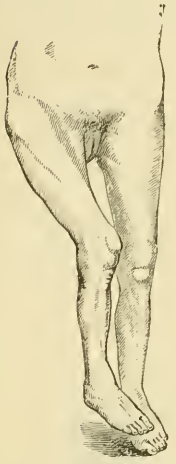
Dislocation on the dorsum ilii, or backward and upward, forms about half of all the cases of dislocation at this joint, and is usually produced by some twisting movement of the body or limb when the latter is abducted or from a crushing weight received when in a stooping posture. It can be recognized by the following signs—viz., the flexed position of the thigh, the knee when the patient stands projecting in front of but above the other; the rotation inward of the limb, the great toe resting on the instep of the opposite foot; the projection of the great trochanter and its approximation to the anterior superior spinous process of the ilium; the elevation of the fold of the buttock; the immobility of the limb and the pain produced by any attempt to abduct or to extend it; and the marked shortening of the limb—from an inch and a half to two and a half inches (Fig. 510).

In thin subjects the head of the bone may be felt lying upon the dorsum ilii, and in

all there will be an unnatural fulness of this part. Slight flexion and adduction will usually be borne, while patients may support the weight of the body on the injured limb or even walk upon it.

Dislocation backward toward the ischiatic notch forms about a seventh of all cases and may be regarded as a variety of the one just described; indeed, Erichsen

Fig. 510.

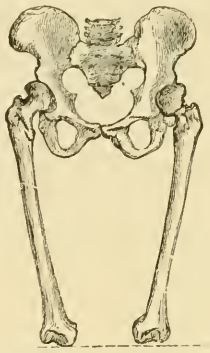


Dislocation Backward on the Dorsum. (Drawing 30⅝.)

Fig. 511.

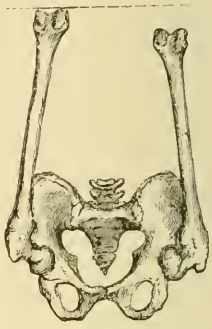
Dislocation into the Sciatic Notch. (From Bigelow.)

Fig. 512.



Position when the Limbs are Extended, the Shortening being Slight.

Fig. 513.



The Limbs Raised to a Right Angle with the Recumbent Trunk, the shortening being very striking.

(From paper by Dr. W. Dawson of Ohio, who subsequently wrote that this test of dislocation had been suggested by O. H. Allis in 1874, *Philadelphia Med. Times.*)

describes the two forms together as the ilio-sciatic. It is characterized by the same, though less marked, symptoms. There is less shortening; but if the patient be placed upon his back and the thigh be flexed upon the trunk at a right angle, then the knee of the dislocated limb will sink below that of the other side from one to two inches (Figs. 512, 513), the trochanter is drawn up and rotated forward, but not to the same extent, and the head of the bone cannot be felt. To the eye the limb assumes much the same position as in the last form, but, there being less shortening, the toes rest on the ball of the great toe of the opposite limb instead of on the instep (Fig. 511). Bigelow believes that this form of dislocation is due to the protrusion of the head of the bone below the tendon of the obturator internus muscle, whereas in the former kind the bone is protruded above the tendon. In this, however, he is wrong, as Mr. Morris has shown that in *all* forms of dislocation the head of the femur makes its exit from the acetabulum below this tendon.

Fig. 514.

Dislocation into the Foramen Ovale. (Taken from a girl æt. 14.)

Dislocation upon the foramen ovale or obturator foramen is a very striking accident. Sédillot as well as Boyer believes that it is the most common of all forms, but British and American surgeons usually place it third on the list. In my own table it stands second. It is generally caused by some forced abduction of the knee or foot, the head of the bone being tilted inward. In the case from which Fig. 514 was taken it was caused by abduction of the knee when the girl (æt. 14) was stepping out of an omnibus.

It is characterized by the bent position of the body and the pointing of the foot forward and slightly outward, the approximation of the trochanter toward the mesial line and consequent flattening of the hip, hollowness below the anterior superior spinous process of the ilium, the absence of the gluteal fold, and the elongation of the limb from one to two inches. Any attempt at movement causes pain. The head of the bone can often be felt in its new position beneath the adductors (Fig. 515). The patient can at times, however, walk with such an injury.

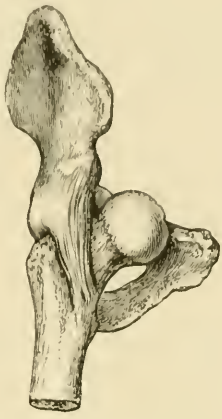
Dislocation upon the os pubis is the least common form of dislocation, and is due to forced extension and rotation outward of the thigh after dislocation by abduction,

the pelvis being thrown forward and the body bent backward as the head of the femur is wrenched out of the socket and then drawn upward.

It is marked by eversion of the limb and foot and abduction, rotation backward of the trochanter, and consequent flattening of this region. The head of the bone can usually also be felt, if not seen, as a projection upon the os pubis (Fig. 516) or on some

Fig. 515. Fig. 516. Fig. 517.

Dislocation into Foramen Ovale.



Dislocation upon Os Pubis. (From Preparations.)

Dislocation upon Os Pubis. (From Astley Cooper.)

part of the lip of the acetabulum. When thrown above the bone beneath Poupart's ligament, it forms a very prominent projection beneath or to the outer side of the femoral artery (Fig. 517).

When the head of the bone is thrown between the anterior superior and inferior spines of the ilium or between the inferior spine and the acetabulum, the head of the bone will be felt in that position.

Diagnosis.—With reasonable care and attention to the special symptoms which characterize the different forms of dislocation, these ought readily to be made out, although certain fractures about the neck of the femur may present symptoms somewhat similar. I have seen two cases of impacted fracture of the neck of the thigh-bone, with the foot inverted and the thigh flexed, presenting symptoms so similar to those of dislocation into the sciatic notch that the diagnosis could not be made out till the patients were brought under the influence of chloroform, when by gentle manipulation the nature of the accident was discovered, the greater freedom with which the head of the bone could be made to rotate in the acetabulum and the limp condition of the limb under chloroform in the case of fracture forming a marked contrast to the immobility and permanent position of the thigh in dislocation. The late Mr. R. W. Smith (*On Fracture*, 1850) records also a case of fracture of the neck of the femur which had been mistaken for dislocation.

When, in the adult, the displacement recurs after the apparent reduction of the bone and the extending force has been removed, the probabilities are that the lip of the acetabulum has been broken off or the head of the femur fractured (*vide* Birkett, *Med.-Chir. Trans.*, vol. lii.), and when in a child the separation of the head of the bone or upper epiphysis should be suspected, it being quite impossible, under both these circumstances, to maintain the bone in position except by means of a long splint or weight to keep up extension. In all cases of a doubtful nature chloroform should be given for purposes of diagnosis, the surgeon using the gentlest manipulation. The sudden loss of mobility, the rigidity of the limb, the absence of crepitus and other symptoms of fracture, with the positive signs of the injuries themselves, are sufficient to indicate the nature of the case. Nélaton's test for dislocation of the hip backward is, however, excellent, and consists of a line drawn from the anterior superior spinous process of the ilium to the most prominent part of the tuberosity of the ischium. In a normal joint the trochanter, in every position of the limb, merely touches the lower border of this line, but in all dislocations where the bone goes backward it is sometimes found an inch above it.

Treatment.—Sir A. Cooper, with the surgeons of his day, considered the muscles about a joint as the chief agents in drawing a displaced bone into its abnormal position

and as forming the main obstacle to its reduction, and, as a consequence they relied upon physical force, in the form of pulleys and other complicated appliances, as the chief means by which this obstacle could be neutralized. The modern surgeon, with anæsthetics in his hands, knows that the muscular system has usually little or nothing to do with the difficulties that are met with in the reduction of a dislocation, that these are found in the ligaments and capsule, and that a large laceration in the capsule allows easy reduction, whereas difficulties must be experienced when the rent is small. With chloroform, therefore, all pulleys and mechanical appliances can be done away with—certainly in recent and probably in old cases. In my own opinion they are never required, for adhesions are more readily broken down by forced flexion and rotation than by simple extension; and if these fail, no extending force will succeed. In dislocations of the hip the reduction by flexion becomes, therefore, a reality, and is one of the greatest improvements in modern surgery.

In the dislocations backward—*ilio-sciatic*—the reduction by flexion is the correct method, adduction, circumflexion, abduction, and extension of the limb being subsequently and successively employed (Fig. 519). In dislocation into the foramen ovale the reduction by flexion is likewise good, with subsequent circumflexion inward and extension (Fig. 518.)

In sub-pubic dislocations the reduction by extension outward and rotation is preferable.

To carry out this reduction by flexion and manipulation, the patient should be placed on his back on a hard couch and thoroughly anæstheticized. The surgeon should then grasp the ankle of the displaced limb with one hand and the ham with the other, flexing the leg upon the thigh and the thigh upon the pelvis, at the same time *lifting* the limb and adducting it toward the opposite side of the umbilicus. Having effected this movement, the surgeon should by a semicircular sweep outward suddenly extend the limb and bring it into a straight line with the body (Fig. 519). If one attempt fail, a second may be

FIG. 518. FIG. 519.

Reduction by Manipulation.
In Dislocation into the Foramen Ovale. (From Bigelow.)
In Ilio-Sciatic Dislocation.

made, and in by far the majority of recent cases success will attend the effort. "If there is any single and best rule for reducing a recent dislocation of the hip," writes Bigelow (*Lancet*, June 15, 1878), "it is to get the head of the femur directly below the socket by flexing the thigh at about a right angle, and then to lift or jerk it forcibly up into its place. This rule applies to all dislocations except the pubic. Flex and forcibly lift; and if this fail, flex and lift while abducting." No roughness should be used, gentle, well-directed manipulation being all that is called for, the leverage obtained through the femur being enormous. Some slight rotation of the limb outward or inward, according to the necessities of the case, at times facilitates reduction. Callender insists (*Lancet*, 1868)—and wisely, I think—upon the importance of *not fully abducting* or rolling the limb outward, as, if this be done, the head of the bone is almost certain to roll past the acetabulum to its inner side; or if an obturator dislocation is under treatment and the thigh is rotated inward, the head of the femur will roll round to the ischiatic notch, just reversing the movement which takes place when an ischiatic dislocation is improperly manipulated. The object of the treatment is to use the femur as a lever to raise the head of the bone from its backward position and allow the stretched muscles to act naturally and draw it

into place, the act of flexion completely relaxing the strong ilio-femoral ligament, the surgeon, with his knowledge of the way in which the head of the bone was driven through its capsule, using his best endeavors to make it retrace its steps, and employing his anatomical knowledge to press, elevate, or guide the malplaced bone into its normal position. The various movements adopted in reduction by manipulation, as well shown by Morris, serve to bring the head of the displaced femur down to the notch in the acetabulum by making it retrace the course it took in the process of dislocation, and then subsequently turning it back through the rent in the capsule by a rotation the reverse of that which occurred during dislocation. This method of reducing dislocations of the hip is known in France as Deprés' method; in America, as Reid's. The former employed it in 1835 (*vide* Nélaton's *Pathol. Chirurg.*, 1847), but Dr. H. Bigelow has proved that the credit of the method is really due to Nathan Smith of New Hampshire (see *Memoirs*, 1831). In a case of dislocation into the foramen ovale in a man I failed in my first attempt by manipulation, but in the second I succeeded by the application of the slightest pressure upon the head of the bone; and in the case of the girl from whom Fig. 514 was taken the head of the bone slipped into its position by simply flexing the leg on the thigh and the thigh on the pelvis, with such gentle pressure as I was applying for a preliminary diagnosis.

In one case of severe injury to the joint that came under my care, where the bone was displaced on the dorsum, on attempting its reduction by manipulation the head of the bone slipped with such facility round the acetabulum as to illustrate every typical form of dislocation and several intermediate or partial forms. In this case, however, reduction was subsequently readily obtained by thoroughly flexing the thigh upon the pelvis and *lifting* the head of the femur from its false position by extension forward.

When the rent in the capsule is small, difficulties may be felt in reducing the dislocation; but when large, little is usually experienced.

At times reduction is thought to have been accomplished when redislocation appears after the limb has been left alone, and under these circumstances it is probable that the head of the bone had only partially been replaced through the rent in the capsule. In other cases of this kind which refuse to remain *in sitû* there is reason to believe that the lip of the acetabulum has been fractured, or, in young subjects, that the head of the femur has separated at the epiphysial line of junction with the neck. Still, without these explanations, cases are met with in which it is quite impossible to keep the limb in position after its reduction. In some cases the reduction of the dislocation occurs by simple muscular movement when the patient is in bed. I have seen several. When reduction by flexion has failed or is inapplicable, that by extension should be employed, and in the pubic form of dislocation no other should be used. It should be practised with the patient under the influence of an anæsthetic and on his back, and as follows: The pelvis should be fixed by a perineal band well padded and adjusted, and the limb extended in the line of its position to draw the head of the bone out of its bed. The surgeon should then either elevate the bone, to allow the muscles to act upon it, or abduct, adduct, or rotate inward or outward, according to the special want of the individual case. In some cases the simple extension of the limb with the unbooted heel of the surgeon placed firmly in the perinæum will answer every purpose.

After-Treatment.—After the reduction of a dislocation the legs should be fastened together and no movement allowed for three weeks, and then only gentle movement; for if this rule be not attended to, redislocation may occur. In a case under my care of dislocation into the foramen ovale, in a young woman, after reduction had been effected, redislocation occurred on the tenth day from crossing the leg over the opposite knee in attempting to cut the toe-nails of the affected limb.

Splints are hardly called for in the majority of cases, although, should secondary inflammation follow or much local mischief complicate the case, they should be applied, with either ice or hot fomentations, the surgeon selecting the application that gives most relief.

Old dislocations, in a general sense, should be left alone, since in the hip difficulties of reduction are always felt and danger is not rarely met with. During the first three weeks reduction is rarely difficult and may always be tried; indeed, within the month good hopes attend the attempt. I have seen a dislocation on the dorsum reduced on the thirty-fifth day with an excellent effect. Dr. H. Croly of Dublin told me in 1879 of a case of dislocation on to the pubis in which reduction was effected on the thirty-ninth day by manipulation after an attempt with pulleys had failed. Success has, however, been recorded in exceptional cases up to the sixth or eighth week, or even after six months,

but failure has more frequently followed the attempt. My colleague, Mr. Durham, in 1873 reduced one after the fifth month. Fergusson states that after three weeks he has never seen a successful attempt. Sir A. Cooper fixed eight weeks as the limit of time up to which the attempt should be made, and without the use of anæsthetics he was doubtless right. When reduction has failed, good movement may often be secured after the lapse of time. The dangers attending attempts at reduction are not theoretical. Inflammation and destruction of the joint are no infrequent consequences, and fracture of the bone has been recorded by many surgeons. Dislocation of the knee or rupture of its ligaments has likewise taken place from the extension employed, and with a fatal result.

When fracture of the femur is associated with *dislocation of the bone*, the latter should, when possible, be reduced by manipulation. In 1860 I saw my colleague, Mr. Birkett, reduce with the greatest facility a dislocation of the head of the femur on the ramus of the pubis in a boy æt. 12 when the femur was broken below the trochanter, the bone slipping into place on the application of gentle well-directed force. Similar cases have been recorded by Bloxam and M. Etène.

If the reduction of the dislocation by these means has failed, some hope remains that when the fracture has united a better success may be secured. Sir A. Cooper has related an example in which reduction by means of extension was effected five weeks after the accident in a youth about seventeen.

Effects of Dislocation.—The sciatic nerve may be injured at times in a dislocation of the hip, and as a consequence paralysis may ensue. Morris shows in his paper how this complication is caused, while Maclise in his illustrations gives a drawing illustrating how the nerve may be stretched, and Hutchinson (*Med. Times*, 1866) recorded a case in which the paralysis was permanent.

Dislocations of the Patella.—These are not common accidents, but seven occurred at Guy's in ten years. When they occur, they are generally caused by muscular action, though at times by the application of direct force. They are most commonly met with *outward*, occasionally *inward*, and very rarely *edgeways*. When the ligamentum patellæ has been torn across, the patella is drawn upward; and authors have described this accident as dislocation *upward*.

The dislocation *outward* is usually seen in women, in whom the femora have a more oblique inward direction than in most men, or in knock-kneed subjects, the bone resting flat on the outer condyle of the femur or on its outer edge; in the former case the outer edge of the patella, and in the latter the inner, tilts forward. The knee is usually slightly flexed; it looks broader and flatter, but the unnatural position of the cap marks the nature of the accident. In 1868 I saw this accident in a male child ten months old; the patella rested on the outer side of the condyle of the femur and was readily reduced.

Dislocation *inward* is very rare and easily recognized. It is always due to direct violence to the outer border of the bone.

Both these accidents are attended with laceration of the synovial capsule.

Treatment.—Reduction is readily effected, usually by raising the heel of the limb, to relax the extensor muscles of the thigh, and manipulating the displaced bone into its position, the elevation of its depressed edge being generally enough to allow the muscles to restore it to its right place. A splint should then be applied, as well as a bag of ice for a few days till all inflammatory action has subsided, the knee being strapped up subsequently for a month or more, to give time for the ligaments to unite firmly. These dislocations, however, are very prone to recur on the slightest cause, and many patients are obliged to wear for life a firm leather knee-cap to guard against such a contingency.

Dislocation of the bone edgeways is a very uncommon accident. I have seen only one such instance, and in it the patella appeared to show its articular facet inward, its inner edge presenting forward beneath the stretched skin. It was in a middle-aged woman, and the displacement was produced by a direct blow upon the knee from a fall off a chair. Mayo has recorded an instance in which the bone had turned almost round.

This dislocation is readily known by the peculiar appearance of the joint.

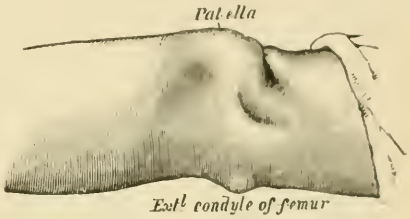
Treatment.—In my own case reduction was effected with ease on raising the leg and turning the patella into its right position with the fingers. Flower succeeded on bending the knee only after chloroform had been given. Cases have been recorded where reduction was impossible, even after the subcutaneous division of the tendon and ligament that is attached to it, and other rough means; but these were employed before chloroform was introduced, which must be their excuse. Under an anæsthetic it is probable that by manipulation the bone will usually be reduced; if not, it had better be left alone. Some sudden muscular effort might be of service.

Dislocation of the Knee-Joint.—This accident can occur only from great violence, the ligaments that bind the bones together being very strong; yet it does occur, the tibia being displaced *backward*, *forward*, or *laterally*. Four examples occurred at Guy's in ten years. When *partial*, no complication, as a rule, exists, and the lateral is usually of this nature; when *complete*, the soft part about the joint and the fibrous tissues within are often so injured as to render it a great question whether the joint, or even the limb, can be saved. The backward and forward dislocations are usually of this kind.

Diagnosis.—When the popliteal artery or vein is injured or ruptured, amputation of the limb may be called for, this necessity being rendered more than probable when the circulation through the vessels is not speedily restored after the reduction of the dislocation or when a swollen condition of the limb remains.

Treatment.—These dislocations are readily diagnosed by the peculiar deformity they display, and are easily reduced by extension and the application of pressure where pressure is needed. In the case from which Fig. 520 was taken pulsation in the vessels was arrested, but it returned on the reduction of the dislocation, and recovery with complete movement of the joint was obtained. After the parts have been replaced in their normal position splints should be adjusted and cold applied, for secondary inflammation is almost sure to follow. In rare cases the displacement is permanent and the limb is left useful. Thus, in a man æt. 20 under my care the left tibia and fibula were displaced partially inward five years before I saw him from a fall in wrestling. The inner condyle of the femur rested on the outer articular facet of the tibia, and the head of the fibula seemed to rest between the condyles of the femur. The man had good though not complete movement of the joint, could walk well and carry loads.

Fig. 520.



Partial Dislocation of the Left Tibia and Fibula Forward. (Taken from a man æt. 23.)

A displacement of the lower epiphysis of the femur with the leg-bones may be mistaken for dislocation of the knee, and in young subjects where this latter accident is supposed to have taken place the surgeon should always consider the probability of the injury being of the former kind. In Fig. 521 this accident is well illustrated; it was taken from a boy æt. 10 who was under my care at Guy's some years ago. The epiphysis had been displaced inward off the shaft of the femur and rotated inward, and the lower end of the diaphysis of the femur was nearly through the soft parts on the outer side of the limb. The parts were restored to their normal position by manipulation and extension and the limb was fastened on a splint; a good recovery with perfect movement of the joint was the result. In some cases fracture coexists, and in exceptional examples, where the end of the diaphysis projects through the soft parts, its resection may be required to allow of its reduction.

Fig. 521.

Separation and Rotation Inward of the Lower Epiphysis of the Femur, with the Leg Bones, from the Shaft of the Femur. (Taken from a boy æt. 10.)

Compound dislocations of the knee are generally so serious as to necessitate the removal of the joint. The attempt to save it should be made in exceptional cases only; amputation or excision may be selected.

Dislocation of the head of the fibula is occasionally met with. I have seen but three examples—one when dressing for the late Mr. Aston Key, and two since. It is generally caused by some violent adduction of the foot, with abduction of the knee, the head of the fibula tearing through its ligamentous attachments and becoming displaced outward.

Diagnosis.—The accident can be readily recognized by the projection of the bone. It should be treated by the application of a pad and pressure over the part sufficient to keep the bone in its place, the limb being flexed when necessary, to relax the biceps femoris. The pressure should be maintained for at least two months if good success is to be looked for; as a rule, the bone never quite resumes its former position, the head projecting more than usual. This deformity, however, does not appear to weaken the limb to any great extent.

Dislocation of the interarticular fibro-cartilages (semilunar) is a recognized accident. It is produced by some sudden twist of the knee with the foot everted, and generally in subjects who have relaxed joints or such as have been the seat of some chronic synovitis. The inner cartilage seems more liable to displacement than the outer.

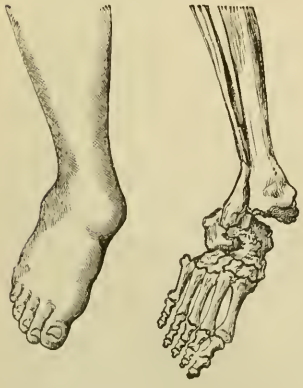
Symptoms.—The symptoms of the accident are well marked. A patient, when walking, accidentally catches his foot against a stone or in rising from a kneeling position is seized with a sudden sharp, sickening pain in the knee; the joint becomes at once fixed in a semiflexed position and any attempt to move it only excites some pain. When the first agony has subsided, a painful spot is usually left, where the projecting cartilage may be felt, or even seen; and if the "internal derangement of the joint," as it was originally called, is left untreated, synovitis or effusion into the joint will soon show itself. When these symptoms follow such an accident as has been described, the cartilage has probably been torn from its attachment to the tibia and been doubled in or displaced.

Mr. J. F. Knott in an able paper (*Dub. Journ. of Med. Sci.*, June, 1882, p. 479) has shown that in "the combined twisting and lateral movement conveyed to the knee at a moment when the ligaments are as lax as possible the margin of the condyle of the femur is *jerked over* the edge of the internal semilunar fibro-cartilage. The immediate result is pressure of this structure, which is increased when the resulting pain brings about spasmodic contraction of the surrounding muscles."

Treatment.—The best practice consists in the forced flexion of the joint, the slight rotation of the leg outward, and sudden extension, pressure with the thumb upon the cartilage above the edge of the inner condyle of the tibia during the flexion and extension often being of use. When success attends this manœuvre, the joint moves smoothly and without pain, and the patient will at once be able to move the joint freely. At times the reduction of the displaced cartilage is attended with a decided snap. After its reduction the joint should be kept in a splint and such means employed as the symptoms that follow indicate, for more or less inflammation often ensues, requiring ice, cold lotions, leeching, and rest. When active symptoms have subsided, it is well to restrain the movements of the joint by means of a knee-cap or strapping, as a recurrence of the accident is liable to follow upon the least occasion. I have on several occasions thought that disease has been excited when this measure has been omitted, and I once saw anchylosis follow. Permanent lameness is by no means uncommon. When the surgeon fails to reduce the displaced cartilage, the patient at times suddenly gains relief by its spontaneous reduction during some accidental movement. In other cases the cartilage resumes its normal condition more slowly. In 1873 I saw a case of this kind where spontaneous reduction always occurred after its displacement. It was in a gentleman æt. 30, and the inner cartilage projected beyond the head of the tibia in a most marked manner. The patient should be kept in bed and allowed only to move the limb, not to stand upon it. When this result is not secured, the joint should be strapped up, to restrain movement.

Dislocations of the Ankle-Joint.—Such an accident uncomplicated with rupture is rare; that is, dislocation of the foot *outward* is generally associated with fracture of the fibula, and dislocation *inward* with fracture of the tibia, or both malleoli may be broken. Pure dislocations of the foot *forward* or *backward*, however, may occur. These dislocations are given in the order of their frequency, and are usually produced by some violent twist or bending of the foot when the patient is jumping, or by some violent impulse of the body with the foot fixed.

Fig. 522.



External Appearances of Foot in Pott's Fracture. (Taken from Pott's work.)

Fig. 523.

Dislocated Foot Inward, with Fracture of Inner Malleolus. (A. P. Cooper.)

Dislocation of the foot *outward* is better known as "Pott's fracture" (Fig. 522), the fibula being usually broken two or three inches above the external malleolus. It is caused by a violent bending of the foot outward with the foot everted, its outer edge being raised and the inner turned downward on the ground. At times the extremity of the inner malleolus is broken off and displaced outward, with the foot and astragalus. Under all circumstances the

lower end of the tibia or inner malleolus forms a prominent projection inward, leading—or *mis*leading—Sir A. Cooper and his copyists to describe this accident as dislocation of the tibia inward. At the seat of fracture of the fibula a depression exists. When the force is continued beyond the point necessary to cause the displacement mentioned, the lower end of the tibia may be made to project through the soft parts and thus give rise to a *compound dislocation*. In still more severe cases the extremities of both tibia and fibula may be made to project, the foot being completely turned outward. Exceptional cases occur in which the foot is turned out of its socket between the malleoli without any accompanying fracture.

Dislocation of the foot *inward* (Fig. 523) is the counterpart of the last-described accident, and is caused by violence that turns the foot inward with its outer edge to the ground. It is usually associated with an oblique fracture of the inner malleolus and displacement. The force required to produce this dislocation is very great, the tibia being a far stronger bone than the fibula; the accident, consequently, is less common. The end of the fibula is often fractured and drawn outward with the astragalus. At times the astragalus is also fractured. The accident is known by the inversion of the foot, the sole looking inward, and by the projection of the external malleolus, this prominent symptom having led Sir A. Cooper to describe it as dislocation of the tibia outward.

When the force is continued or more severe, either the fibula or the fractured—or, rather, exposed—ends of both tibia and fibula may be made to project through an external wound; in still more severe cases I have seen this more than once, and in one a sound recovery ensued, with a movable joint. It was, however, in a boy æt. 12. I simply reduced the dislocation after washing and dressing the wound, and fixed it in splints.

Fig. 524.

Dislocation of the Foot Backward. (Cast 165, Guy's Mus.)

Dislocation of the foot *backward* (Fig. 524) was called by Sir A. Cooper dislocation of the tibia and fibula forward. It is usually caused by the violent propulsion of the lower end of the leg-bones forward when the foot is fixed, and is readily recognized by the shortening of the anterior surface of the foot and the proportionate elongation of the heel, with some pointing of the toes as well as prominence of the lower end of the tibia. At times the fibula is fractured and the point of bone carried backward with the astragalus.

This accident is rare, it being more common to meet with fracture of both malleoli and displacement of the foot and broken fragments backward.

In 1862 I was called to treat a very marked case of this kind in a man æt. 32. The astragalus with the foot seemed to have been shot completely out of its socket, and the extremities of the tibia and fibula projected so far forward as almost to rupture the soft parts covering them. The accident was caused by wrestling. The dislocation was reduced by flexing the leg on the thigh and by manipulation, but no means could be found to maintain the bones in position till the tendo Achillis was divided and the leg placed on its side and fixed on an outside splint. Mr. Cock (*Guy's Rep.*, 1855) has recorded a case of the same accident in a boy æt. 16, where the same difficulty was experienced. He divided the tendo Achillis and bound the foot in splints, and a good result, as in my case, was obtained.

Dislocation of the foot forward is probably more rare than the last, and is generally only partial. It has been described as dislocation of the tibia backward, and is known by precisely the opposite symptoms to those last described. The heel is shortened and the foot lengthened, the upper surface of the astragalus being capable of recognition by the fingers. Poland records such a case (*Guy's Rep.*, 1855) in which the whole foot was much elongated, and the posterior part of the astragalus was caught in the anterior part of the tibia and fibula and wedged in tightly. Reduction was effected only after the division of the tendo Achillis.

Treatment.—The lateral displacements of the foot are not difficult of reduction by extension and well-directed manipulative force. The flexion of the knee facilitates this operation by relaxing the muscles of the calf.

To keep the bones in position a Macintyre or flat posterior splint extending up to the popliteal space, with foot-piece and two side splints, all well padded, are sufficient as a rule, the surgeon using his judgment as to the amount of pressure and padding that may be demanded. In some cases where it is a very difficult matter to keep the parts quiet,

from the action of the gastrocnemii muscles, the tendo Achillis should be divided, the foot after this simple operation being perfectly passive and entirely in the hands of the surgeon to place and to keep in any required position.

The limb should subsequently be slung in a proper swing, Salter's being the best. In hospital practice two or more pieces of bandage slinging the splints to the cradle answer well. In the displacement of the foot forward or backward the same kind of treatment is applicable, but in these accidents it is expedient, as a rule, to divide the tendo Achillis at once. This should be done at any rate when the slightest disposition to displacement is found to exist, the treatment of the case being by this operation rendered more simple and certain.

The splints should be retained for at least six weeks, and afterward passive movement should be allowed. The patient should not bear any weight on the limb for another month.

The treatment of *compound dislocation of the ankle-joint* cannot be reduced to any definite rules. Each case must be treated on its own merits. In young and healthy subjects more may be attempted in the way of saving the joint than in the old or cachectic. When a small wound exists, operative interference is only exceptionally needed; but when a large one with projection of the bones, it is a question whether the better practice lies in the reduction of the dislocation after cleansing the projecting bones or in their resection. When the bones cannot be reduced by ordinary force, their resection becomes a necessity. When the bones are much crushed, their resection should always be undertaken; indeed, it is a general feeling in my own mind that in compound dislocations, as in compound fractures with a large wound, it is wiser to resect the ends of the projecting bones than to reduce them. Amputation of the foot should be performed only when the soft parts and the bones are much injured and the age of the patient or his want of power forbids the hope that a recovery with a useful limb can be secured. Before any attempt at reduction is made the parts should be thoroughly cleansed. After the reduction of the dislocation, whether simple or compound, the application of ice or cold is of great value, or the treatment by irrigation. In the suppurative stage the latter practice is probably the better of the two. When the wound is of only a limited nature, it may be sealed at once, either by lint soaked in blood, or, what is better, by the compound tincture of benzoin. The joint in such cases may be washed out with a weak solution of carbolic acid (one part in forty) or iodine water before the wound is sealed. Opposite the wound an interrupted splint should be employed.

Secondary amputation may be called for in these cases, on account of gangrene or a failure in nature's efforts to effect repair, etc.

Fig. 525.

Dislocation of Ankle—Astragalus between Tibia and Fibula. (Cast 160, Guy's Mus.)

Dislocation of the tibia and fibula at their lower articulation, with a forcing of the astragalus upward between the two bones, is an accident which must be recognized (Fig. 525), and is usually produced by a jump from a height on the foot or feet. I saw a good example of it in 1869, in both feet of a man æt. 55 who fell from a scaffold. The malleoli were widely separated and projected, the depth of the foot from the extremities of the malleoli was lessened, and the movements of the foot were almost gone. No fracture could be made out. It was impossible to move the bones from the position in which they were wedged, although all means were used. Yet a good recovery took place, though with stiff joints. I have seen a like case since in a man who jumped from a high window, but in it some fracture of the astragalus complicated the injury; the man did well.

Dislocations at the tarsal joints are met with in practice, although but rarely. They are difficult to diagnose, and still more difficult to classify, since they are so variously described by different writers. The first to be noticed is *subastragaloid dislocation of the foot*, in which the astragalus maintains its normal position with the tibia and fibula, but loses it with respect to the rest of the foot. Mr. Arnott communicated to the *London Med. Gazette* (vol. xv., 1837, p. 588) the report of a case in which he and Mr. A. Shaw recognized the nature of the accident; but the possibility of such an accident was doubted till Mr. Pollock in 1859 (*Med.-Chir. Trans.*, vol. xlii.) published two cases; one occurred in Mr. Keate's practice in 1823, and in it the os calcis and scaphoid, with the other foot-bones, were displaced *outward* off the astragalus. In the other, which occurred in his own practice, the same bones were dislocated *inward*. A dissection of this case is

given. In Keate's case the foot was everted and the head of the astragalus projected on the inner side of the instep. In Pollock's the foot was inverted, so that the sole turned inward as in varus; the external malleolus was very prominent and the astragalus projected on the other side. In some instances the surfaces of the foot are maintained in their right line. In Mr. Pollock's case reduction was found to be impossible till the tendo Achillis had been divided, when it was readily accomplished. In an able paper he advocates this practice whenever difficulty of reduction of the inward or outward dislocation, simple or compound, is experienced, and shows that the division of the posterior tibial tendon is occasionally called for in the outward. Mr. Turner of Manchester had previously advocated the same practice (*Trans. Prov. Med. and Surg. Assoc.*, vol. ix.).

In 1882 a man æt. 36 came under my care with displacement of the foot *outward* off the astragalus and slight eversion of the foot. The head of the astragalus projected through a large wound in the soft parts above and within the tubercle of the scaphoid and above the tendon of the posterior tibial muscle. Reduction was found impossible until a portion of the head of the bone was removed, when the parts were replaced and the case went on to a satisfactory conclusion, with movement in the ankle-joint.

Fig. 526.

Dislocation of Foot Inward off the Astragalus. (After W. MacCormac.)

An admirable paper on this subject has been published by Sir W. MacCormac (*St. Thomas's Hosp. Rep.*, 1872). The woodcut produced (Fig. 526) is taken from it, from which it will be seen that "the foot was violently inverted and adducted, its position being like that of talipes varus. The sole of the foot looked inward and was nearly vertical; the outer edge of the foot, with the patient erect, would rest partially upon the ground. The great toe pointed toward the arch of the opposite foot. The inner border of the foot was somewhat shortened and more concave, while the outer was more convex than natural and appeared as if lengthened. The outer malleolus was very prominent, while the inner could not be perceived, so deeply was it buried. Neither malleolus was fractured, and this would seem to be almost characteristic of this form of injury. The rounded head of the astragalus, completely dislodged from the scaphoid, was resting subcutaneously over the calcaneo-cuboid articulation. The prominence caused by the head was somewhat masked by swelling of the soft part just below it. The skin covering the head was so tensely stretched that it seemed ready to burst, and a circular slough subsequently formed at the spot. The outline of the head could, however, be easily traced, and the finger, on being passed upward beneath the external malleolus, readily felt the cartilaginous surface of the large posterior articulating facet of the astragalus. Most of it was quite subcutaneous, and its external margin rendered the skin very tense. The interosseous ligament had been ruptured. The tuberosity of the scaphoid stood out prominently and a depression could be felt behind it. The motions of the foot were very limited." Macdonnell of Dublin (*Dub. Journ.*, 1839) published a case in which the same bones were displaced *backward*, where the heel projected, and a marked prominence existed on the dorsum of the foot, with an abrupt descent in front on the tarsus.

In 1862 I had to amputate the foot of a man æt. 24 for a compound dislocation of the foot *backward* off the astragalus, with fracture of the calcis. When seen, the foot was turned inward and much fore-shortened and there was a bony eminence in front of the external malleolus, which turned out to be the displaced anterior third of the os calcis. The accident was caused by the man's foot becoming wedged between the spring and the step of a locomotive and his body falling outward. On dissection the astragalus was found in its normal position, between the malleoli, but with its head resting on the scaphoid bone, between the tendon of the tibialis anticus on its inner side and of the long common extensor on the outer. On the outer side of the foot the displaced portion of the os calcis was resting on the dorsal surface of the cuboid bone; the rest of the calcis was completely dislocated backward, its upper and posterior articular facet projecting beyond the astragalus. The extreme end of the external malleolus was broken off. The peronei tendons maintained their position behind the external malleolus, but were much stretched.

M. Parise (*Annales de la Chirurg.*, 1845) gives an instance—which is apparently unique—of dislocation *forward*, in which marked elongation of the foot existed and the projection of the heel was effaced.

All these dislocations are rare. The first example of dislocation inward that I have

seen was recorded by Mr. Cock in *Guy's Hosp.* Rep. for 1855, with a drawing; but in my work *On the Joints* (1859) I published (Case 85) an example of dislocation of the foot outward, with a description of the dissected extremity, which had occurred in the practice of Mr. Aston Key in 1845. The foot was amputated, reduction being impossible. The ankle-joint was perfect. The os calcis with the foot was displaced outward. The tendon of the tibialis posticus was found in front of the tibia holding down the astragalus. The posterior tibial nerve was violently stretched over the astragalus. The limb was removed for tetanus, and the symptoms immediately disappeared after the amputation. A large number of these cases are compound, and in some they are complicated with fracture of the fibula. Broca (*Mém. de la Société de Chirurg.*, tome iii.), out of thirteen examples of dislocation outward, gives nine as compound.

This dislocation may be diagnosed from displacement at the ankle-joint and dislocation of the astragalus itself by the fact that extension and flexion are present; from fractures about the ankle by the absence of crepitus, together with the positive signs of the injuries themselves.

Treatment.—Reduction should be attempted only with the patient anæsthetized, and under such an influence, by extension and manipulation, success may be looked for. When difficulties are experienced, Turner and Pollock's suggestion of dividing the tendo Achillis, and even the posterior tibial tendon, or any other tendon when it is clearly interfering with the replacement of the bones, should be followed. When these means fail and the stretched skin gives way, the case must be treated as one of a compound nature and the astragalus partially is excised, the foot being subsequently well confined in splints and ice applied. Occasionally amputation may be demanded, or Syme or Pirogoff's more partial operation.

Dislocations of the Astragalus alone are said to be more common than the former accidents. I have seen several such, but I am disposed to think I have mistaken some cases of sub-astragaloid dislocation for dislocation of the astragalus. Pollock believes the pure dislocation of the astragalus to be very rare.

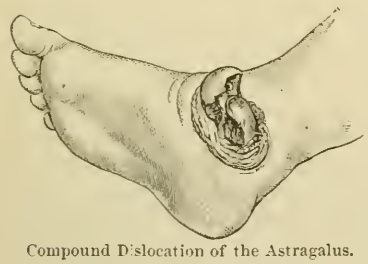
The bone may be shot out of its socket *forward*, *backward*, and even *laterally*, and in rarer examples *rotated* on its axis.

In the dislocation *forward* the head of the bone projects from between the malleoli, in some being shot inward so as to form a marked eminence beneath the internal malleolus, in others outward. In such an accident the heel remains in its normal position and all movement of the ankle-joint is lost.

The dislocation *backward*, of which Phillips (*Med. Gaz.*, 1834) and Turner have cited examples, is indicated by the remarkable projection which suddenly appears above the heel, pressing out the tendo Achillis by the shortening of the foot and the prominence of the tibia in front.

Dislocation of the *astragalus laterally* to be complete must be compound (Fig. 527), and when incomplete at first will probably become complete at a later period through sloughing of the soft parts. It is generally, but not always, complicated with fracture of one or other of the malleoli. Boyer has recorded a case of dislocation of the astragalus *inward* in which no such complication existed, and in *Guy's Reports* for 1861 (p. 293) I recorded an example of dislocation of the bone *outward* in a man æt. 51 in which both malleoli were entire; the astragalus had been fractured and turned completely out of its bed and was found hanging to the wound below the external malleolus. I removed the broken fragments at once and brought the foot into a good position; a complete recovery with a stiff joint ensued. Sixteen years after the accident the man walked about without the aid of a stick and with no other inconvenience than that occasioned by a stiff joint, which he maintained was a very slight matter. Fig. 528 illustrates a case of dislocation of the bone outward, complicated with fracture of the fibula.

Fig. 527.

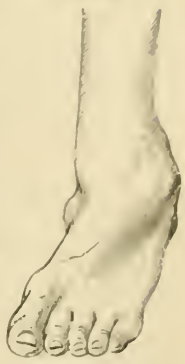


Compound Dislocation of the Astragalus.

Rotation of the bone often coexists. Mr. Barwell has written (*Med.-Chir. Trans.*, vol. lxvi., 1883) an interesting paper upon this subject, and gives a case in which he resected the astragalus with a good result. He tells us "the bone may be turned either horizontally, so that its long axis looks across the joint and at right angles to its normal position," and this he would call version, "or it may turn over sideway upon its antero-posterior axis, which might be termed torsion." That Mr. Barwell is right there can be no doubt. In 1878 I removed from the inner side of the ankle-joint of a man the

necrosed upper half of the astragalus that had its articular facet looking inward. Six months previously he had received an injury to his ankle which was regarded by the surgeons who treated him as one of fracture of the leg.

Fig. 528.



Dislocation of the Astragalus Outward, and Fracture of the Fibula. (Cast 161.)

Treatment.—In simple dislocation of the astragalus, when the bone can be replaced by manipulation, nothing more is needed; but such a result cannot always be secured. When it cannot, even under chloroform, the tendo Achillis should be divided. In 1862 I was called to see a man æt. 28 who had fallen on his feet from a height of four yards, and whose right astragalus was shot forward completely out of its socket and nearly burst through the skin. In this case chloroform had been given and every kind of manipulation and extension employed by competent men to reduce the bone without effect. I divided the tendo Achillis, extended the foot fully, and applied gentle pressure to the projecting astragalus, when the bone slipped back readily into its place. Some crepitus was felt, however, and I believe a horizontal fracture of the astragalus coexisted, the upper surface and head of the bone having been displaced forward. The foot was fixed in side splints, and a good recovery ensued with a movable joint.

When the displaced bone cannot be restored to its normal position directly after the accident, it is now fairly a settled question that it should not be removed till after the tissues have sloughed. Sir A. Cooper strongly advocated this practice, and Broca has since supported him, showing by an analysis of cases that in 36 examples of irreducible simple luxation in which the bone was removed at once, one-fourth were fatal, while in 43 in which the bone was left alone only 2 deaths took place; in 2 amputation was performed; in 16 the bone was removed after sloughing, and all recovered; in 23 no operation was called for, recovery taking place with a useful limb.

In all compound dislocations of the astragalus the removal of the bone should always be effected.

Dislocations of the other tarsal bones have been recorded. Malgaigne relates two cases of *dislocation of the calcis* outward, the bone forming a projection beneath the external malleolus and beyond the cuboid articulation. In 1865 I saw a case of Mr. Birkett's at Guy's in which the left *scaphoid bone* was displaced inward and formed a very marked projection. It was readily reduced by pressure under chloroform at a moment when the distal end of the foot was drawn outward. I have the notes also of a case of dislocation of the *internal cuneiform* bone upward with the metatarsal bone of the great toe in a man æt. 24; of a second, in a man æt. 30, in which the same bones were displaced inward, the accident having been produced by a weight falling on the outer ankle when the foot was resting on the great toe. In both reduction was readily effected with a good result.

Holthouse informs us that the internal cuneiform bone may be separated from all its articulations and thrown upward and inward. The three cuneiform bones are also sometimes luxated together upward, and without much difficulty may be reduced by pressure.

The *scaphoid* and *cuboid* bones may also be displaced. Malgaigne has described this accident as a middle tarsal dislocation; Liston has described it in his *Practical Surgery*, and Sir A. Cooper in his work *On Dislocations*.

Dislocations of the *metatarsal bones* may likewise occur. In 1854 I saw a case, recorded by Mr. Cock (*Guy's Rep.*, 1855), in which the entire metatarsus appeared to have been separated from its attachment to the cuneiform and cuboid bones and thrown on the dorsal surface of the instep, where their bases could be seen and felt. The internal cuneiform and navicular bones appeared to have been likewise injured. The injury was the result of a crush from the wheel of a railway wagon. All Mr. Cock's efforts at reduction failed, but a good foot was secured, and the man subsequently returned to his work as a laborer on the railway.

In March, 1884, a man æt. 36 came under my care with displacement of the three inner metatarsal bones upward and outward, caused by the passage over the foot of the wheel of a cart loaded with a ton and a half of bricks. Under chloroform and by manipulation the bones were readily reduced, and a good result ensued. I suspected at the time there was a fracture of the third bone.

Dr. Hetzig (*Sydn. Soc. Bien. Rep.*, 1865–66), who gives us an analysis of 29 cases of these tarso-metatarsal dislocations, states that 13 were of single bones, 16 of the entire

metatarsus, some of these being lateral and others vertical, as in Cock's case. In the former greater inconvenience follows, from a failure in reduction.

Dislocations of the phalanges are less common than those of the finger and chiefly occur upward, from direct violence to the ends of the toes, and, as a rule, are compound. The great toe is the one usually injured, and, as in the thumb, considerable difficulty is at times met with in its reduction, the ligaments and many tendons around the joint affording an explanation of this fact. Such a case should be treated in the same way as dislocation of the thumb. Reduction must always be effected, when possible, by extension and well-directed pressure; forced flexion or extension sometimes facilitates the process.

Congenital Malformations (Dislocation) of Joints.

It has been the habit of authors to describe cases included under the above heading as examples of *dislocation*, but it is clearly more correct to regard them as malformations, for as met with in the shoulder, clavicle, wrist, and lower jaw they are always associated with a want of development in the bones and paralysis of the muscles of the part.

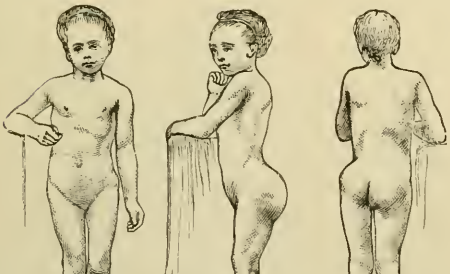
In Hip-Joint.—When seen in the hip, there is likewise good reason to believe that congenital deficiencies are also present, as the anatomical facts which bear upon the point support this view; one such is given by Cruveilhier in the second plate of the second volume of his *Pathological Anatomy*, where an engraving of a skeleton in which this congenital displacement existed shows it to be the result of a want of depth, from incomplete formation, of the acetabulum, and another is furnished by a valuable preparation in the Middlesex Hospital Museum (Prep. 12, Series 3), in which there is practically no acetabulum, but a strong capsule and a well-developed head of the femur, without a ligamentum teres.

Dr. A. G. Drachman (*London Med. Rec.*, May 18, 1881) reports a case of a child born of a mother with this deformity, who died on the seventh day, in which the left acetabulum was considerably shallower than normal and the ring of cartilage was turned outward at the superior, posterior, and outer part, forming an inclined plane over which the head of the femur glided upward and backward on the ilium. The whole of the left side of the pelvis was atrophied and the atrophy extended to the head of the femur, which, as well as the head of the bone on the right side, was small.

Mr. Barker pointed out in a discussion at the Roy. Med. and Chir. Soc., November 17, 1883, that in the Musée Dupuytren the specimens showed either absence of the ligamentum teres or its lengthening to a mere cord two and a half inches long.

This *congenital displacement of the hip* is by no means an uncommon affection, and is often mistaken for hip or spinal disease, more particularly when one joint alone is implicated. It affects both joints in one-third of all cases, and occurs in female rather than in male children in the proportion of 5 to 1. It is found also in those who are in all other respects well in health and perfect in form, and, although it has been boldly *asserted* that "it is beyond doubt that this dislocation is produced at birth through downward force applied to the thigh in endeavoring to hasten the birth in breech presentations," no evidence has been published to support the view. On reviewing my own experience I must add that it does not in any way encourage such an opinion, for, whilst in no case have I been able to learn that a breech birth took place, I heard in the majority that a natural birth occurred.

Fig. 529. Fig. 530. Fig. 531.



Case of Congenital Displacement of both Femora. Anterior view. Side view.

Congenital Displacement of Head of Left Femur. (Posterior view.)

Symptoms.—The symptoms of the displacement are very marked, and in its double form are well shown in the foregoing drawings, taken from life (Figs. 529, 530), the most conspicuous being lordosis, a peculiar breadth of hips, rounding of the buttock, rotation of the whole extremity and foot inward, and slight flexion of the thigh—in fact, the symptoms of dorsal dislocation of the hips.

The lordosis is produced in these cases in the same way as it is in the accidental dorsal dislocation or the acquired displacement of the head of the femur in hip disease, and can be effaced by elevation of the limb with the patient in the horizontal position, as in those cases (Figs. 609, 611).

The movements of the joint are good, at times perfect, and give rise to no pain. The head of the femur also rotates smoothly on the ilium.

When one joint only is affected (Fig. 531), there will be shortening of the limb for about an inch, and on comparing the affected with the sound side it will be at once seen that this shortening is in the thigh and that the trochanter is drawn up to the level of the anterior superior spine of the ilium.

The walk of a patient with a double displacement is very curious: it is a kind of "roll," not unlike that of a woman who has some loosening of her sacro-iliac joints or very broad hips, when going up stairs, while a patient with a single affected joint limps and has an awkward gait which has often led parents and others to suspect hip or spinal disease, more particularly when by overuse of the malformed joint pains are excited. Occasionally the muscles of the affected limb or limbs are weak, but this is met with only in exceptional cases.

Treatment.—Nothing can be recommended with the view of cure, for art cannot supply a natural deficiency or make up for a defect of structure in the bones of the joint. Still, surgery can do much toward the prevention of additional trouble by exercising the muscles of the limb and body without fatiguing them, forbidding excessive standing or walking during the years of growth, and attending to the general health.

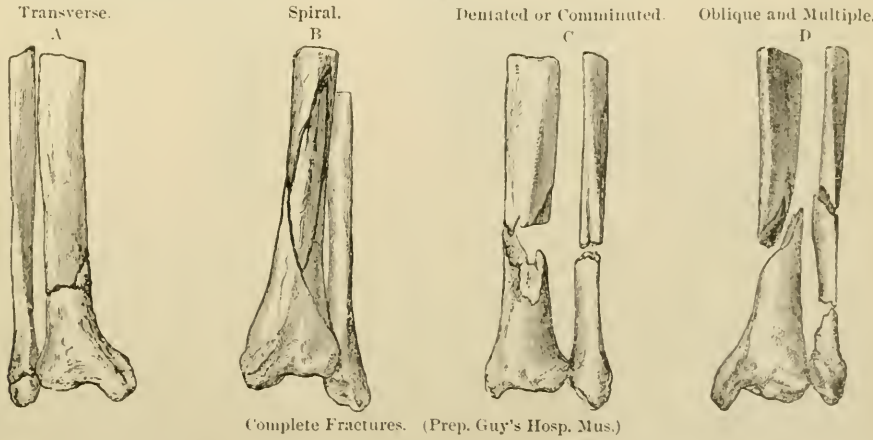
Mechanical appliances are to be condemned as useless, if not worse. They have been employed on a wrong principle—or, rather, on a want of due appreciation of the conditions of parts—and therefore with only a vague hope that they may do good. These observations apply as much to the use of an extension apparatus as to operative interference, although with more force to the latter.

CHAPTER XXXI.

ON FRACTURES.

When a bone is broken, it is said to be fractured; when the skin and soft parts covering in the broken bone are whole, the fracture is *simple* or subcutaneous; when a wound exists *communicating with the broken bone*, whether the wound be caused directly

Fig. 532.



Complete Fractures. (Prep. Guy's Hosp. Mus.)

by the same force that produced the fracture or indirectly by the bone perforating the skin, the fracture is *compound*. A simple or compound fracture is said to be *complete* when the solution of continuity is complete; *incomplete*, when the bone is only *cracked*,

fissured, or *bent*, as in *green-stick* fracture, where the bone is splintered on its convex surface, and not on its concave; *splintered*, when only a portion of the bone is cut off, either by a sabre wound, in machinery, or by some local injury chipping off the edge of a bone; *fissured*, when the line of fracture extends partially or wholly through the bone and no separation of the fragments exists; *impacted*, when one end of the broken bone is driven into and fixed in the other. A bone may also be *perforated* by a gunshot or punctured wound.

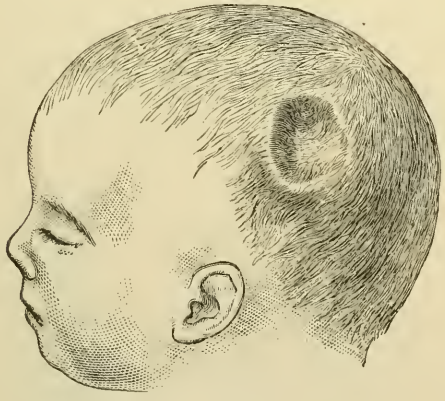
A **complete fracture** may be transverse, oblique, longitudinal, spiral, dentate, or comminuted; multiple of the same bones or of contiguous bones, of separate or distinct bones (*vide* Fig. 532). All fractures may likewise be complicated with other injuries, those into joints being the most important. Fractures and separations of epiphyses are also intimately connected, but fractures may occur at any age, while separation of the epiphyses is rarely found in subjects above twenty-one.

A fracture may be met with at every period of life; indeed, it may occur *in utero* from some external violence; and, when the accident has taken place some time antecedent to birth, repair may have gone on to completion, although in most cases with deformity, the *vis medicatrix naturæ* being, as Billroth well observes, a better physician than surgeon. I have seen this in an infant who was born with a humerus bent at right angles, evidently from a repaired intra-uterine fracture. During the delivery of a fœtus, by turning the shaft of a femur, tibia, or fibula may be displaced from one or both of its epiphyses. By hyperabduction of the femur the upper epiphysis of the bone is likely to suffer, and by traction on the foot those of the lower end of the tibia and fibula (Dr. Alexander Simpson, *Edinb. Med. Journal*, June, 1880; M. Delore, *Dict. Encyclopéd. des Sciences Médicales*, iv. 201, 1879). The fractures of infancy are comparatively rare and are commonly incomplete, or "green-stick." Fig. 533 illustrates this in the clavicle and Fig. 534 in the parietal bone. The latter was taken from a child æt. 8 months who was thrown out of a perambulator on the pavement. No symptoms of brain disturbance followed the accident at any time. The drawing was taken on the second day following the accident. The case

Fig. 533.

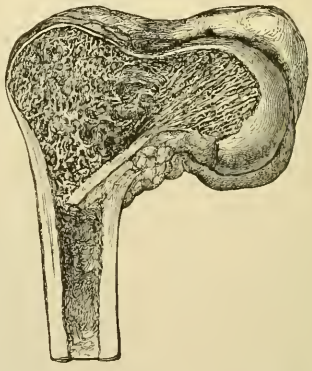
Incomplete Fracture of the Clavicle. (From *Holmes's System.*)

Fig. 534.



Incomplete Fracture of the Parietal Bone of Infant.

Fig. 535.



Impacted Fracture of the Neck of the Thigh-Bone. (Taken from a man æt. 64, who recovered from the accident.)

occurred in the practice of Mr. Harris of South Hackney. In some such cases as these the depression in the bone may, as time passes, be gradually pressed out, but in others it is permanent.

Fractures in the adult are mostly complete, though an incomplete fracture may occur. **Impacted fractures** (Fig. 535) are chiefly found in the aged, the bones at this period of life being more brittle than they are in younger subjects. They are commonly met with in the neck of the femur and the lower end of the radius, although they occur in the neck of the humerus and other parts. Thus, in Fig. 578 is illustrated an impacted fracture of the shaft of the femur. Many *comminuted* fractures are doubtless due to

impaction of one fragment of bone into the other, and to the subsequent splitting of the latter.

Men are more exposed to fractures than women, on account of their more constant liability to injury, and those bones suffer the most that are the most exposed to external violence; hence the frequency of fracture of the lower extremities.

Bones in some subjects are very brittle and break from slight causes; *fragilitas ossium* is then said to exist. This condition may be hereditary. These bones, however, as a rule, unite rapidly. In August, 1883, I saw a case of fracture of the neck of the thigh-bone which took place when a woman æt. 83 was slowly walking from her bed to a chair.

Diseased bones are always predisposed to fracture from slight causes, more particularly the rickety and cancerous, and likewise bones that are weakened by the presence of tumors or some syphilitic or other inflammatory affection.

In diseased or brittle bones muscular action may be enough to cause fracture. Thus, I have known a thigh to be fractured in turning in bed, in an epileptic attack, and in swinging it over the side of a cart; the humerus in the act of embracing a wife, and in a man æt. 26 from throwing a stone; the clavicle, from lifting a heavy weight; the ribs, in coughing; the radius, from wringing clothes; and every surgeon knows how frequently the patella, and more rarely the olecranon, are broken from muscular spasm. Mr. Parker records (*New York Journ. of Med.*, July, 1852,) a case in which a dentist æt. 38 broke his humerus while drawing a tooth. Mr. J. Anningson of Burnley has recorded a case of a woman æt. 42 in which the upper three-fourths of the tuberosity of the calcis was fractured and displaced upward by muscular action (*Brit. Med. Journ.*, January 26, 1878). Mr. Ball likewise records a similar case (*Dublin Path. Society*, November, 1880).

Patients with disease of the nerve centres are very prone to suffer from fracture. Davey in 1842 noted the fact that lunatics often so suffered, and the frequency of broken ribs from slight causes in lunatic subjects can be explained by this liability. Weir Mitchell in 1873 (*American Journ. of Med. Science*, July) first called attention to the connection between fracture and locomotor ataxy and suggested impairment of nutrition as the cause. Later on Charcot emphasized the fact, and at the same time noticed how rapidly repair took place in the broken bones.

"From a review of the observations made on the bones of two insane patients," writes Dr. Omerod (*St. Bart. Hosp. Rep.*, 1870), "it may fairly be inferred that the brittleness of the ribs depended on a morbid condition of the bones, and that this condition was general, affecting different parts of the osseous system coincidentally, though more marked in the ribs than in some other more compact bones. The process was essentially one of absorption of the internal structure of the bone, the osseous tissue being replaced by an excessive deposit of the fatty matters normally existing in its interior. Thus the usually invisible membrane lining the Haversian canals, and forming the coats of the vessels lying there, was thickened into a membrane of cognizable structure and dimensions. The space for this thickening was obtained by removal of the innermost concentric laminæ, and from this point a change was propagated which resulted in or tended to the removal of each entire Haversian system. In the whole bone there was a loosening of the mutual connection of the laminæ and an obscure disintegration of the osseous structure itself, and a general infiltration of oily matter into the substance which had intruded itself within the Haversian canals, and into whatever part of the compact structure of a bone could find room for it."

In confirmation of these views I may mention that I attended, with the late Dr. Black of Canonbury, a middle-aged lady the subject of dementia and epilepsy who in nine or ten fits, none of them having been violent, broke a bone, and on several occasions two. The fractures took place by mere muscular action when the patient was in bed, and repaired well—indeed, as well as if the subject of them had been quite healthy.

The immediate cause of fracture is usually some *direct* violence applied to the part, or it may be *indirect*, the bone, under some bending force, giving way at its weakest point—"in the line of *extension*, not that of *compression*" (Teevan).

Indirect fractures are, as a rule, of the simplest kind, unless complicated with joint dislocation; when compound, the soft parts are mostly injured by the protrusion of the fractured bone.

Fractures the result of **direct violence** are always the most severe, the same violence that breaks the bone injuring the soft parts over it, and often fissuring and comminuting it.

The mode of production of a fracture is, consequently, a point of great practical importance, alike for diagnosis, for prognosis, and for treatment.

Symptoms.—The *diagnosis* of a fracture is usually easy, though in exceptional cases it is difficult, if not impossible. It is easy when, after a blow or fall attended by the sensation of something giving way, *deformity* is found, with *inability to move the limb*, and on manipulation *abnormal mobility* of the injured limb exists, with *crepitus* from the rubbing of the broken fragments together; when *pain* attends any attempt at movement and *swelling* rapidly follows the accident; and when *shortening* exists, which is remedied by extension.

The diagnosis is difficult when, as in *impacted fractures*, abnormal mobility and crepitus are absent and only slight but fixed deformity exists, when local pain and shortening are the only symptoms, and when the nature of the accident is the only guide; when a transverse fracture of such a bone as the tibia exists without displacement and with no fracture of the fibula; when the fracture is into or in the neighborhood of a joint and there is much swelling of the injured part; and when a fracture and a dislocation coexist.

It is always difficult, and at times impossible, to make out a simple fissure of a bone, cranial or otherwise, and the same may be said of a fracture of the pelvis or thorax; such injuries as these can be made out only by the natural symptoms of fracture, as they are called, and by such as are referred to the contents of the cranial, thoracic, or pelvic cavities.

When a bone is broken near a joint and effusion into it follows the injury, the surgeon should suspect the presence of a fissure of the bone into the articulation; and when a V-shaped fracture of the lower third of the tibia is present, the V occupying the *internal* or *subcutaneous surface* of the bone, and *not* the crest (*vide* Fig. 594), this complication is to be looked for.

It is sometimes difficult to diagnose a fracture from a separated epiphysis.

When a fracture is *transverse* (Fig. 532, A), there may be no or only some slight lateral displacement; when *oblique* (Fig. 532, D), there will probably be some shortening of the limb, from the drawing up of the lower portion of the limb, or *riding*, as it is called, of one end over the other. At times there will be rotation of the limb, and in comminuted fractures separation of the ends of the bone (Fig. 532, C). These points will be greatly determined by the character of the fracture, the bone that is involved, and the amount of muscular action that influences the fracture.

In parallel and conjoined bones of which only one is broken the deformity that exists is likely to be less marked than where a single bone is broken, for under these circumstances the non-fractured bone tends to neutralize the action of the muscles through which deformity or contraction usually takes place. Muscular action is undoubtedly the main cause of deformity, tonic action of the muscles existing under all circumstances, and spasmodic action when the muscles are irritated by fragments and attempts at reduction.

Muscular spasm being the main cause of deformity and shortening of the limb after fracture, it becomes an important point to recollect in treatment that the peculiar deformity associated with any special form of fracture can be obviated by neutralizing the action of the muscles that produce it. Thus, in fractures of the humerus *above* the insertion of the deltoid, the action of the latter muscle will be to draw the lower fragment up and outward, while the pectoral muscle has a direct influence in drawing in the upper fragment. In fractures of the humerus *below* the insertion of the deltoid the tendency of this muscle will be to draw the upper fragment outward, and the brachialis anticus has an equally powerful tendency to draw the lower half forward. In fractures of the thigh-bone below the minor trochanter, the psoas and iliacus muscles naturally draw the upper fragment forward and rotate it outward, and in fracture of the condyles the gastrocnemii have a powerful tendency to draw the lower end backward.

When a bone is fissured, and not displaced, the periosteum not being divided, there will be but little displacement; in children this condition is often found.

Crepitus, or the grating sensation caused by the rubbing of the ends of the broken bones together, is a most valuable sign of fracture, and when detected during the examination of a limb supposed to be fractured the diagnosis is made clear; but when other symptoms of fracture sufficient for a diagnosis are present, it need not be looked for. In impacted fractures, as of the hip, it can be felt only on loosening the impacted fragments, and consequently by doing irremediable harm; this error is serious and should be avoided. In incomplete fractures crepitus is also absent. In fact, every fracture or suspected fracture should be manipulated with the utmost gentleness, in order that as little displacement and local injury may be inflicted as possible, for the bulk of fractures can be made

out with certainty without crepitus. As a symptom, however, it is always of great value.

The crepitus of effusion or of the theeæ of tendons must not be mistaken for that of a broken bone. It is a soft crepitus rather than a hard one, as in bone. Bursal crepitation is particularly liable to mislead.

When some swelling follows immediately upon the accident, it means ruptured blood vessels, arterial or venous. When it occurs within a few hours, it is due to inflammatory effusion.

In all cases of supposed displacement the normal condition of the limb must be inquired into and the sound compared with the affected, for in more cases than one I have known a natural or old acquired deformity in a limb mistaken for one caused by an accident, and attempts have been made to restore—or, rather, to reduce—the parts to their supposed normal condition.

Prognosis.—Simple fractures, as a rule, do well. At Guy's, in six years, out of 469 cases of simple fracture of the thigh, 17 died, or 3.5 per cent.; of 888 examples of simple fracture of the leg, 8 died, or not 1 per cent.; of 123 cases of fractured patella, there was no death.

The same statistics inform us that one-tenth of all cases of fracture of the thigh are compound, as are also one-fifth of all fractures of the leg.

Compound fractures are always serious accidents, those of the upper extremity being less fatal than those of the leg, and these less so than those of the femur. Thus, at Guy's, in six years, out of 94 cases of compound fractures of the arm and fore-arm, 16, or 17 per cent., died, or 1 in 6 cases; out of 202 cases of compound fracture of the leg, 56, or 27.7 per cent., died, or 1 in 4 cases; and out of 52 cases of compound fracture of the thigh, 19, or 36.5 per cent., died, or 1 in 3, the mortality increasing by 10 per cent. in each group. These statistics, however, but roughly indicate the risks of the different accidents, as they include smashes of limbs with the compound fractures.

As a cause of death after fracture of the long bones Professor Czerny of Freiburg has proved in an able paper (*Berliner Klinische Wochenschrift*, Nos. 44 and 45) that "fat embolism" is to be taken into account, the fluid fat of the bones being taken up by the veins and carried to the central organs—brain, lungs, and kidneys, etc.—and thus causing death. This result, he states, is a common cause of death when a bone is much fissured and the cancellous tissue laid open, as in the V-shaped fracture of the tibia, and more particularly when this is compound. He does not inform us how this accident can be avoided.

Treatment.—The principles of the treatment of fractures are very simple, though the practice is often very difficult. To restore a bone to its normal position and to keep it there by means of surgical appliances, or, as John Hunter expressed it in 1787, "to place the parts in a proper position by art—that is, as near their natural position as possible—and to keep them so," are simple rules to be observed, but to carry them out often demands the highest surgical skill and ingenuity; and yet the whole treatment of fractures is really comprised in these two indications.

In examining a fracture the greatest care is requisite, and only sufficient manipulation should be allowed to ascertain the *seat* of the fracture, the *line* of its direction, and the *tendency* a fragment may have to ride in any direction, this special tendency being the one point to be remembered in the treatment. These points, moreover, should be made out at the single examination prior to treatment, for repeated examinations, whether by the responsible surgeon or by his assistants, are to be condemned, as they can only do mischief by exciting more local irritation than is necessary and adding to the injury which the muscles and soft parts have already sustained. For this reason when, after an accident, a fracture is suspected to have taken place, the surgeon or bystanders should do no more than bind the limb to some immovable apparatus, such as a wisp of straw, a bundle of sticks, or two pieces of wood fixed by a handkerchief, till the sufferer has been carried home and placed in the position in which he is to be treated. When the lower extremity is the affected part, the injured limb may be bound to the sound one, the latter acting as a splint.

In compound fracture the same precautions are necessary. Bleeding should be arrested by the application over the wound of a pad or bandage kept in position by means of pressure and the elevation of the limb, while in more severe cases the tourniquet or some local pressure over the main artery may be called for.

If these precautions are not observed on the field, many lives may be lost from hemorrhage, simple fractures may be turned into compound, while compound fractures may be made worse.

When a patient is placed in bed where he is to be treated, the fracture ought to be manipulated and its *position*, *nature*, and peculiar *tendency* made out, and when made out to be "set," or put up, at once. The only exception to this rule is when time has been allowed to pass before treatment is commenced and much œdema or swelling of the injured extremity exists, then it is better to fix the injured limb raised upon a pillow, with a long sand bag on either side, to act as a splint, and possibly a third round the foot, the pillow and side sand bags being firmly bound together by a strip of bandage and the whole forming an immovable apparatus. Mr. Aston Key, indeed, was so fond of this mode of putting up fracture of the leg that in my "dresser" days it was the usual mode of treating them all through their course—that is, for the first month or five weeks, till they could be put up in some starch or other immovable apparatus and the patient allowed to get up. The method is comfortable and satisfactory to the patient, but it wants closer attention on the part of the surgeon than can often be given.

In "setting" a fracture some care is needed, and the opposite and corresponding limb should always be before the surgeon as a guide. Inquiries should also be made as to the condition of the limb before the accident—whether it was deformed or shortened from any previous fracture or disease, congenital or otherwise; for I have known an injured leg to have been likewise violently and unnecessarily manipulated to restore a supposed fractured bone to a position that it could not be made to assume on account of some natural deformity, and likewise a fractured thigh subjected to like rough treatment to bring it down to the level of its fellow, when an irremediable shortening existed from a former fracture.

In extending a broken limb to restore the bones to their normal position, the upper portion should be firmly held by an assistant to make *counter-extension*, and the muscles attached to it relaxed by placing the limb in a slightly flexed position; a second assistant or the surgeon may then extend the fractured end, while the latter gently manipulates the fracture, to make out its points. The extension should be steady and free from all jerks and violent movements, gentle lateral, rotatory, or other movements being given as required to restore the displaced portion of bone, the pressure of the thumb or finger being freely used to bring about an accurate coaptation or setting of the fragments; for the surgeon must remember that muscular contraction is better overcome by *continued extension* than by temporary force, and that for the treatment of fractures generally moderate extension continuously applied is preferable to forcible extension in any of its forms. The inhalation of chloroform at times is a valuable aid in the reduction of a fracture.

If, when the fractured bones have been reduced, muscular spasm is so severe as to render it impossible to keep them *in sitû*—a condition which is not uncommon in fracture of the leg—the tendon of the offending muscle may be divided. In otherwise intractable fracture of the leg there is no operation of greater value and attended with less evil than the division of the tendo Achillis. In a general way, however, the muscular spasm ceases after the first three or four days.

When the fracture has been reduced and by manipulation coaptated or "set," splints or other mechanical appliances are necessary to keep the bones in their normal position; and the simpler these appliances are, the better, so long as they fulfil their purpose. These splints should always be well padded, and the pads so adjusted as to fit into the inequalities of the limb and protect it from any local pressure. They should be firmly and immovably fixed to the limb by inelastic straps or bandages, and the seat of fracture, as a rule, should be left exposed for the surgeon's examination, in order that the fracture may be readjusted if displacement take place. To cover up a broken bone by bandages or splints is a mistake. The position of the bone during the progress of repair should always be open to view, the former practice being based on hope, the latter on certainty. Pott's rule, that the splints should include the joint above as well as below the fracture, is sound, though it cannot always be followed. Every joint, however, should be fixed when by its action the broken bone is rendered movable.

When one bone is broken in a limb where double bones exist, the second acts as a splint and keeps up extension. Under these circumstances a simpler apparatus is required to keep the fractured bone quiet and restrain the action of the muscles that move it than under other circumstances.

Extension is a valuable and necessary adjunct to other treatment, and should be kept up by means of weights, pulleys, or such other appliances as the ingenuity of the surgeon may suggest. These means however, will be described in the treatment of special fractures.

After the setting of the fracture, the essential point to be observed in its treatment is the immobility of the broken bone; and next to this, its exposure to observation during the progress of repair to render certain that the bone has maintained its right position.

Treatment of Compound Fractures.—The treatment of compound is similar to that of simple fractures, *plus* the treatment of the wound with its complications and the broken fragments or projecting portions of bone, "but *rest* of the bone is the great object we have to aim at" (John Hunter, 1787).

These fractures should be "set" in the same way as the simple, great care being observed in the manipulation that the soft parts are not more injured; loose fragments of broken bone must be taken away, projecting portions excised, and the bone reduced, the wound being enlarged when necessary to facilitate this act; the injured parts, too, ought to be thoroughly cleansed and all wounded vessels twisted or ligatured; the bones should then be fixed immovably by means of splints, interrupted splints often being required. When the wound is not very extensive, it should be sealed by means of a piece of lint saturated with blood, or, what is better, with the compound tincture of benzoin. If the carbolic acid dressing is employed, the wound should be well washed with a weak solution of one part in a hundred and dressed under the spray. The wound should be interfered with as little as possible, since now, as when the following words were uttered, "the great mischief and bad success arising in the treatment of compound fractures is the dressing them every day and applying fresh poultices, which necessarily move the ends of the bones. *The limb, if possible, should never be moved*" (John Hunter, MS. lect., 1787).

When the soft parts are much crushed and the large vessels and nerves injured, amputation may be called for, more particularly in old subjects.

In compound fractures "scarcely any amount or form of fractured bone alone," writes Skey (*Operative Surg.*), "would justify the immediate resort to the knife if taken singly, even supposing the bone fractured extensively into a large joint; for in such a case, although anchylosis of the joint would probably occur, it would prove a lesser evil than that of amputation. Superadded to a compound or comminuted fracture of bone, the injury may be rendered yet more serious by extensive laceration of the muscles. In considering this latter condition much will depend on the kind of laceration—whether the muscles are merely cut asunder or whether contused or torn, and whether this injury involves a few only or the majority of the muscles of the limb. Again, we must examine with great care the condition of the vessels. Is the main trunk whole? we might ask in the supposed case of fracture of the thigh, or in that of the leg. Is the posterior tibial artery torn? Is the limb colder than its fellow, or is the temperature considerably lower than the rest of the body? If so, probably one or more arteries are divided. What is the condition of the nerves? Does sensibility extend to the toes? If not, probably the nerve is divided also. If the evidence of the integrity of both artery and nerve fail and the sinking temperature of the limb and the loss of sensibility continue to increase, we have no alternative but amputation."

If a doubt exist in the mind of the surgeon as to the necessity of *immediate* amputation, he should wait, unless the patient be old, in which case let him act promptly.

Simple fractures into joints require special treatment, as in a large number of cases, although not in all, some impaired mobility of the joint will ensue; for this reason the joint itself should be placed at the most useful angle and so fixed.

Compound fractures into joints generally demand excision or amputation. In the *upper* extremity, when there is any hope of saving the limb, excision is doubtless the better operation. In the *lower* the expectant treatment is certainly better than excision, and probably better than amputation if the parts are not so injured as to render amputation at once a necessity, and if the age and general condition of the patient justify an attempt to save the limb; but these points will again have to be considered among the special fractures. In gunshot wounds these views are now generally entertained.

The Fracture Bed.—The best is, without doubt, a good horsehair mattress placed on a bedstead with a firm bottom; but where this does not exist, a board beneath the mattress is a good substitute. A canvas bottom, however tightly corded, always yields, and a feather or ordinary spring bed is not to be sanctioned. The woven wire mattress is excellent.

The sheet covering the bed should be stretched and kept smooth several times daily, so that no "ruck" takes place, bedsores being more frequently caused by such than by pressure. In fracture of the lower extremity the head of the patient should not be raised too high, the use of one small pillow being ample.

Splints made of wood, iron, felt, or perforated zinc may be employed, and the different forms will be given when the special fractures are considered. As a rule, the simpler in construction they are, the better; and before adapting one to the broken limb it is well to fit it to the sound. The splints should invariably be quite clean.

Pads.—All splints should be well padded and their edges carefully protected. The pads should consequently be well fitted, broad, and overlapping the sides. The best materials for these are tow or fine oakum, cotton or sheep's wool, or strips of thick flannel enclosed in a casing of soft linen or lint. The pads should be first fixed to the splint by tapes, or, what is better, by some pieces of strapping.

Besides wooden and iron splints, the "immovable apparatus" for fractures is a very favorite one, and the material employed may be left to the fancy or convenience of the surgeon.

In fractures of such single bones as the fibula or tibia, where no displacement exists, their primary treatment by some immovable apparatus is very valuable, the limb being either put up at once before swelling has appeared or as soon as the swelling, etc., has subsided. In other cases it is inexpedient to employ it for at least ten or fourteen days, until swelling has gone and a certain amount of repair taken place. In the fracture of long bones, such as the femur, it is better to postpone its application until union is complete. Some excellent surgeons—and among them Erichsen—employ the immovable apparatus from the very first. The mode of its application is as follows: In all cases the limb should be cleansed and carefully dried, the bone itself being well protected by cotton-wool or a flannel bandage. The bandage, with the stiffening material, is then to be prepared, and should be put on as smoothly as possible, no more "turns" being employed than are absolutely necessary.

Splints of gutta-percha, millboard, leather, Cocking's poroplastic or hatter's felt, or perforated zinc may be employed as additional supports when complete immobility is demanded. The first five materials, after having been cut to pattern, should beforehand be well softened by immersion in hot water or hot air and then moulded to the limb: the zinc should be carefully cut to fit it and well adjusted. These splints should be applied over the cotton-wool or flannel bandage, and the prepared bandage then bound round. When *starch* is used (Seutin's bandage), it should be exterior, two or three coats being employed. The same may be said when the *white of egg* or *dextrine* is employed. When *gum and chalk* are used, the same mode ought to be followed, the mixture consisting of equal parts of finely-powdered gum and chalk made into the consistence of thick paste by the addition of boiling water gradually stirred into it. This bandage is more solid than the starch.

Mr. de Morgan prefers the *glue bandage*, the best French glue, after having been soaked in cold water and melted in a glue-pot, being applied like the starch; the addition of about one-fifth of methylated spirit to the solution of glue hastens the drying.

When *plaster of Paris* is employed, the bandage should be of some loose texture, and that made of book muslin or crinoline is probably the best. It should be prepared beforehand by well rubbing fresh dry powder into its texture, and should be made ready for use by being thoroughly wetted in a bowl of water for two or three minutes, some additional plaster being rubbed with water into the bandage as it is unrolled, to strengthen the whole.

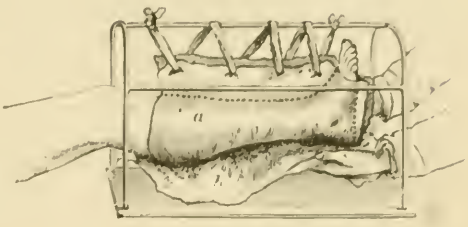
When the surface is extensive, the setting of the plaster may be *delayed* by the addition of a little size or stale beer to the water with which it is mixed, while salt and the use of warm water increase the *rapidity* with which the plaster sets.

The day following the application of this bandage a coating of flour paste, gum, or even a coating of varnish, may be applied, to prevent chipping.

In the appendix to the *Army Medical Report* for 1869, Mr. Moffitt describes the Bavarian mode of putting up a fracture in an immovable apparatus—a mode which deserves to be more widely known than it is. I have tested it well, employing gum and chalk instead of plaster of Paris, and can strongly recommend it; being simple, it can be applied very quickly, and is most effective. It is now in general use at Guy's, and is applied as follows: The materials required to make it are a piece of stout, coarse "house-flannel" which has been shrunk, some precipitated chalk, mucilage of gum acacia, a good-sized cradle, and a stout needle and thread. When it is applied to the leg for fracture, two equal-sized pieces of the flannel are first cut, long enough to reach from the lower border of the patella to three inches below the heel, and in breadth about six inches more than the circumference of the calf, so as to allow the edges to overlap for about three inches when the flannel is folded round the leg. One of these pieces should now

be applied to the leg, its centre corresponding with the centre of the calf, and its two flaps brought tightly together over the skin (Fig. 536), where they should be firmly stitched together, the stitches being inserted close to the bone. The stitches must be begun at the upper part, carried down to the hollow of the instep, and then fastened off. Having arrived at this point, the next thing is to see that the foot is at a right angle with the leg; if left alone, it will probably be at a very obtuse angle, and considerable force is sometimes necessary to bring the toes up, which must be done now or not at all. The stitching must next be begun on the sole of the foot, commencing at the toes and proceeding toward the heel, the flannel being tightly dragged downward.

Fig. 536.



Bavarian, or Immovable, Splint.

a, First layer of flannel, applied to limb. *b*, Second layer, about to be applied.

The stitching along the sole of the foot being completed, the remaining piece along the dorsum of the foot may next be stitched, and after this there can be no fear of the foot changing its position.

The limb will now be tightly encased in a layer of flannel the edges of which are lying in adaptation in front of the leg. The flannel along the sole of the foot to within an inch of the stitches should next be cut off and the edges turned back. At present the superfluous flannel along the front of the leg and dorsum of the foot should not be interfered with, but the limb slung up to the cradle by three or four pieces of bandage pinned or stitched to the adapted edges of flannel in front of the leg (Fig. 536). This will have the effect of stretching the flannel and making it more closely adapt itself to the shape of the calf, ankle-joint, etc., and allow the gum and chalk to be easily applied. The next thing is to make a thick paste of the gum and chalk, the consistence of honey, by stirring them together in a basin, which should be spread thickly over the surface of the flannel with a brush or rubbed in with the palm of the hand, care being taken that it enter all the little inequalities of the flannel. Having done this, apply the outer layer of flannel, placing it just as the first was placed, with its centre corresponding with the median line of the calf, folding its edges closely around the leg and bringing them up together in front over the edges of the previous layer. Keep them also in position in front by about half a dozen stitches, put through at intervals down the leg close to the shin. Along the sole of the foot this layer of flannel may at once be neatly finished off by turning in the edges and joining by stitches. The whole should now be left suspended to the cradle for about twenty-four hours to dry, at the end of which time it may be taken down and the splint removed from the leg by cutting up the stitches along the front of the leg and dorsum of the foot with a pair of scissors, aided by forcibly separating the adjacent edges of flannel.

It now only remains to trim up the splint by cutting off the superfluous edges, binding them with strips of leather made adhesive by being spread with resin plaster, and inserting eyelet-holes at equal distances all down, so as to lace the splint up the front (Fig. 536, A).

If the splint is required for a *knee-joint*, some modification of the above plan is necessary. It will not do to suspend the limb to a cradle by the edges of the flannel, as in the previous case, but the patient should be seated in a chair before a fire with the heel resting on another chair. Then the first layer of flannel should be tightly applied, its edges being brought up together in front and stitches inserted close to the leg. The gum-and-chalk paste may now be thickly spread over the surface of this flannel and covered in by a second layer of flannel, exactly as in the previous case. This second layer may be fastened in front by a few stitches and the whole allowed to dry. When quite dry, the adjacent edges of flannel may be forcibly separated and the stitches divided with scissors. Lastly, the superfluous edges may be cut off, two semilunar pieces cut out for the patella, the margins bound with leather, and eyelet-holes inserted for lacing up in front. To apply the splint to the *hip-joint* it is necessary that the first layer of flannel should surround the pelvis as high as the crests of the ilium, and also the affected thigh. It should then be stitched along the outer side in one continuous seam and the superfluous edges allowed to remain in apposition. The gum-and-chalk paste must then be applied, some difficulty being probably experienced in applying it over the sacrum, but the patient must be rolled first to one side and then to the other. While this is

being done the second layer of flannel should be lying underneath (so as to protect the bed), which may then be adapted and fastened closely by a few stitches along the line of the previous sutures. When the whole is dry, it may or may not be found necessary to rip it up and insert eyelet-holes. If the splint fit closely, without causing any undue pressure, the edges may be cut off close and the whole allowed to remain as it is; but for the sake of cleanliness, especially in children, it is generally better to cut up the stitches along the outer side, bind the edges with leather, and lace it up, so as to allow the splint to be removed as often as requisite.

When extra stiffness is required in any of these splints, the inner surface of the second layer of flannel may be covered with the chalk paste before it is applied; some strips of tin or a piece of gutta-percha which has been moulded to the part should be introduced between the two layers of flannel.[1]

Mr. Croft has suggested a very excellent modification of the Bavarian which is much used. It is made as follows:

1. A piece of house-flannel or an old shrunk blanket, or any suitable substitute, is selected. The pieces may be shaped by measurement, taking the circumference of the limb above and below the knee, at the biggest part of the calf, just above the ankle-joint, from the front of the ankle-joint round the heel to the front again, and at the middle of the metatarsus. The flannel of each splint should be in width half an inch less than half the circumference at any of those points. The width of the two splints should be one inch less than the circumference of the limb at any corresponding part; it should be long enough to extend from above the knee to the middle of the metatarsus. Four pieces are required—two for each splint. 2. Two bandages of common muslin are prepared, each five to six yards long and two inches and a half in width. 3. A handful or two of good dry plaster is mixed with water to the consistence of thin cream. 4. The inside pieces of flannel may be laid on the table or bed, the outer surface being upward. 5. The outside pieces are to be soaked in the plaster separately and laid out on their respective inside pieces.

Whilst traction is kept up and the ends of the broken bones are maintained in apposition, the splints are to be applied and smoothed; then the bandage is to be put on. Traction is to be maintained during the hardening of the plaster. The latter takes place in about three minutes. Next, the limb should be laid on a large, soft pillow, the toes directed upward, and the knee a little bent. In the application of the bandage great caution should be observed that it is not drawn tightly anywhere and that no one turn of the bandage is tighter than another. The support is to be equal everywhere. The two splints should not meet by about half an inch down either the front or the back. The intervals are spanned by the dry porous muslin; at the sides the bandage is fixed to the splints by the plaster, which oozes into it from the outer layer of flannel. If it become necessary next day, or later, to ease the splints or to inspect the limb at any spot, the bandage can be slit up with scissors along the middle line in front. One or both of the splints can then be eased from the limb and readjusted by the addition of another bandage. It is undesirable wholly to remove the splints. They are hinged together at the back by the muslin bandage which spans the interval there. The trimming of the apparatus may be done as soon as the plaster shall have hardened. Should the surgeon be short-handed with regard to assistance, he may apply the outside splint first and lightly bandage that on; and when that splint has nearly hardened, he may put on the inside one. As swelling subsides and the splints become more or less loose an additional bandage should be put on. At the end of ten days, if the patient be convalescing, the outside bandage may be gummed or a fresh gummed bandage rolled on. That apparatus will last until splints are no longer needed. At the end of a fortnight or three weeks, as the case may be, the patient may leave the hospital for his own home.

This mode of treatment is admirably adapted to oblique fractures accompanied by displacement of the tibia, to cases of Pott's fracture, and to comminuted fractures.

In cases of compound fracture an opening suitable to the wound may easily be made. This splint is as good for joint cases as for those of fracture; indeed, it is by far the best immovable apparatus we possess.

Mr. Hyde has introduced a "leather-felt-splint" of great value which is readily applied, is light and strong, and rarely requires to be used with starch. Cocking's poroplastic splint answers the same purpose, the splint becoming soft on immersion in hot air or water, and hard again within a few minutes of its removal. If, when moulded, it fails to fit exactly, it can be softened locally by the application of a hot-water sponge.

[1] I am indebted to a valued pupil—Mr. W. H. Harsant—for the above description of the splint.

Mr. L. Tait (*Med. Times*, 1865) has suggested the use of paraffin for the same purpose, the melted paraffin being kept liquid by the immersion of the bowl containing it in hot water, the bandage as it is being applied being made to pass through the liquid paraffin, melting at 105° to 120° F. Two or more coats of paraffin may be painted over the whole.

The liquid glass—*silicate of potash*—may also be used, the solution being painted over the bandage with a brush. I have used it, and like it, but not so much as the splint I have described.

By way of caution it should be stated that all starch, chalk, and plaster-of-Paris splints contract on drying, and from such contractions I have known harm, and even gangrene, to follow. To guard against this contingency when bandages are used cotton-wool should be applied freely around the limb, although in the Bavarian splint this precaution is not called for.

On this account the practice of using these splints as a primary application in the treatment of fractures is dangerous; for when swelling to any extent takes place, the pressure may be most harmful.

When pain or swelling of the limb follows the application of any of these splints, they should be at once removed, the whole being cut up with strong scissors from end to end, eyelets being subsequently introduced for laces to draw them together again, or straps and buckles may be employed.

Repair of Fractures.—In children broken bones repair rapidly, four weeks being ample time for the whole process to be perfected, while in the aged ten weeks or more may be needed. Repair goes on more rapidly when the broken ends of the bones are placed and kept in position than when they are apart or not kept at perfect rest. When bones are maintained accurately in position or are impacted, direct union ensues, as in the soft parts; but when movement is allowed, reparative material is poured out around the broken fragments and the provisional callus of authors or the ensheathing callus of Paget is formed, which, acting as a temporary splint, keeps the bones in position till they unite by means of the permanent callus. The best repair of a fracture is the direct; and when provisional callus exists, some mobility of the broken bone has been allowed, to a certainty. This addition to our knowledge is due to Sir J. Paget, for until his day a provisional callus was always looked upon as a necessary means for the repair of every fracture. We now know it is present only when mobility of the fragments interferes with direct repair, and in proportion to the amount of provisional callus may the extent of mobility be estimated.

When a bone is broken, blood is effused, the amount depending upon the degree of injury to the soft parts and the amount of comminution of the bone; it is exceptional to find blood between the broken bones. In simple fracture the periosteum may be only torn across; in the comminuted it is more extensively injured, while in incomplete fractures it is probably always entire.

After a simple fracture some slight inflammatory exudation may be poured out around the broken bone, which in healthy subjects is very limited and unattended by any constitutional symptoms. In more complicated cases or in cachectic subjects the effusion may be extensive and constitutional symptoms with febrile disturbance severe. Under favorable conditions this inflammatory material will be absorbed with the effused blood. The true reparative material is poured out about the sixth or ninth day, and when no displacement exists it will be effused only between the ends of the broken bones; when, however, the bones are comminuted, it will be more diffused. When they are misplaced, it will be still less defined; and when the periosteum is much separated or torn, it will be poured out around the bones as a provisional callus. The true reparative products are chiefly poured out by the periosteum and endosteum, though the soft parts around at times add their quota. In the flat bones the ossification of this reparative material has a preliminary fibrous-tissue stage, and in the long, after the blood has been absorbed, the cell infiltration passes on to the formation of connective tissue, or *neoplasm*, which subsequently ossifies, in rare cases passing through the stage of fibro-cartilage. In children it is probable that the cartilaginous stage always precedes the osseous, while in adults the bone is poured out at once, which is probably always the case in all rapidly-repairing fractures.

Ossification may take place in the periosteal blastema or in the endosteal, or in both, these points being greatly determined by the relative position of the broken ends of the shaft of the bone and the comminution of the fragments, great displacement and separation of the fragments being bridged over or cemented together by irregular masses of connecting bone tissue.

When immobility of the broken bones has not been maintained, the bone cement or

provisional callus will be very extensive. In the ribs, where it is impossible to prevent movement, there is always some ensheathing callus; indeed, Dupuytren's ring of provisional callus is constant. In the clavicle also it is common. In other bones it will vary with the amount of movement that has been allowed in their treatment. When the movement is very great, the process of ossification will not go on kindly and ligamentous or fibrous union will remain, giving rise to an ununited fracture, and occasionally a false joint is formed. (A splendid example of this is represented in Fig. 537.) The rapidity with which ossification or true bony union is obtained in fracture depends much on the degree of immobility ensured to the broken bones and on the constitutional power of the patient.

The periods in which the several parts of the reparative process are usually completed after fractures of adult human bones are reckoned thus according to Paget: To the second or third day after the injury, inflammation in and about the parts; thence to the eighth or tenth, seeming inaction, with subsidence of inflammation; thence to about the twentieth, production of the reparative material and its gradual development to its fibrous or cartilaginous condition; thenceforward its gradual ossification—a part of the process which is most variable as to both time of commencement and rate of progress, and which is probably rarely completed before the ninth or tenth week.

In open or compound fractures repair goes on very much in the same way as in simple; when they are made simple by sealing the wound, precisely the same process goes on. When the wound is left open and suppuration takes place in the soft parts around the broken fragments, repair goes on through granulation, the granulation tissue subsequently ossifying and passing into bone cells: the process of repair under these circumstances is thus more gradual than where the reparative material is poured out between the broken bones and proceeds directly to ossify.

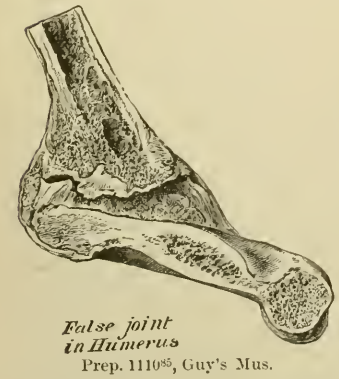
At times after a simple fracture, but more commonly after a compound, the fractured bone inflames, and as a result the broken fragments die wholly or in part; repair is retarded and cannot be perfected until the necrosed bone has been cast off or removed. In comminuted compound fracture this result is more common than in less complicated cases. In gunshot injuries of bones this comminution of the bone is the chief point of difference between them and other compound fractures.

Compound fractures, as a rule, require for their repair three or four times the period required in simple.

Ununited fractures are met with when from any local or general cause ossific union is delayed or does not take place between the broken ends of the bones, and in by far the bulk of cases this is the result of a want of that complete rest and quiet which is so essential for the ossific union of a broken bone. When the ends of the broken bone are kept asunder, ossific union is likewise sure to be retarded or prevented, and also when any muscle or fascia is placed between the broken fragments. In feeble, cachectic, and syphilitic subjects the same want of repair may likewise be met with.

Failures in the reparative process depend, therefore, on some failure in the general power of the patient, want of care in the local treatment of the case, or on some local cause. The union, however, is, as a rule, simply delayed.

Fig. 537.



False joint in Humerus
Prep. 1110[85], Guy's Mus.

Hamilton calculates that such delayed union occurs once in 500 cases, but this average I believe to be too high. It is chiefly found, according to Norris (*Amer. Journ. of Med. Sciences*, 1842), in the thigh, leg, arm, fore-arm, and lower jaw. I have seen it, however, in the clavicle and in the ribs, and cases are recorded in which it was met with in the spine.

In the majority of cases the union of the broken bones is by fibrous tissue which has failed to ossify. In Prep. 1110[80], Guy's Museum, this condition is well exemplified, the ends of the bone being pointed and firmly joined by ligamentous tissue. The length of this tissue varies in different cases. In exceptional instances the ends of the bone are rounded and enclosed by a strong capsular ligament, and thus a false joint is formed, which is well exemplified in a specimen of fracture of the fore-arm (Guy's Museum, 1119[20]), but still better in that of the humerus (Prep. 1110[85], Fig. 537), in which the ends of the bone are studded with fibro-cartilage and complete movement existed.

In more rare cases there is a total absence of all uniting medium.

Treatment.—Regarding a large majority of cases of ununited fracture as examples of delayed union due to a want of that absolute immobility of the fractured limb which is so necessary for its repair, the most essential point to be observed in treatment is the application of an absolutely immovable apparatus, which may be found in one of the forms of splint described as immovable, such as that of starch, egg and flour, chalk, plaster of Paris, or liquid glass, with gutta-percha, millboard, zinc, or felt, the joints above and below the broken bone being included in the apparatus, while tonic treatment is at the same time observed.

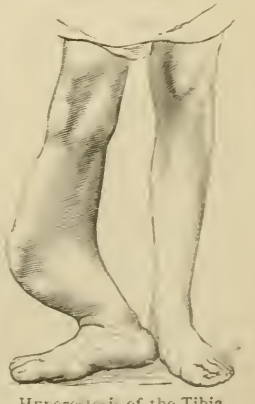
When the limb is thus firmly fixed, rest and the non-use of the limb is scarcely necessary; indeed, under certain circumstances, the moderate use of the limb seems to be beneficial, and in several cases under my care repair seems to have been hastened by such a license. John Hunter saw the truth embodied in these remarks, having asserted in 1787: "When the uniting process in fracture is backward, the parts should *not* be kept at perfect rest. I have seen fractures of the leg which would not otherwise unite do so after patients were up on their legs, the fractured bones being well supplied with iron splints, etc." (MS. lect.). When these means fail, the ends of the bone may be well rubbed together to excite action before the reapplication of splints or subcutaneously scored with a tenotomy knife, while in still older cases the bones may be fastened together by means of wire sutures or drilled and secured with ivory pegs, the credit of this latter suggestion being due to Dieffenbach. Dr. Physick of New York years ago (1804) suggested the introduction of a seton between the ends of the broken bones, and Norris reports that good success has followed the practice, 54 out of 72 cases being successful. The object of the treatment is to excite local action between the fragments: and when this is secured, the seton may be removed. With the same view Malgaigne introduced acupuncture needles between the bones, and Miller and M. Blandin subcutaneously scraped with a tenotomy knife the ends of the bones or the connective tissue.

Resection has also been practised, and, according to Norris, with success in 37 out of 64 cases. The operation, however, is formidable, and should be undertaken only where there is no hope of minor measures being successful, the ends of the fragments being far apart and the condition of the limb such as to render some risk justifiable to gain the desired end. I have performed this operation for ununited fractures of the femur and humerus with excellent results, in some cases wiring the bone together.

Dr. H. J. Bigelow of Harvard has, however, met with considerable success in detaching the periosteum for about half an inch from the extremities of the affected bone with the muscles, taking off the ends of the bones and securing the resected portions together by strong wire passed through half the thickness of the shaft of either fragment: the periosteal flaps may also be united by sutures. The limb should then be fixed on a splint. The wire can be left in place without fear from two to six months. He cured ten out of eleven cases where this operation was performed (*American Journ. of Med. Sciences*, 1867).

It occasionally happens that a fracture which had united becomes disunited after fever, scurvy, or other enfeebling cause, and I have had one very marked case of this in the person of a young lady who had her thigh fractured abroad and subsequently became the subject of tropical fever. In her case, although the bond of union completely gave way, she subsequently obtained a firm limb by means of local immobility and constitutional tonics. These cases ought to be classed with others in which the cicatrices of burns or old ulcers break down under some enfeebling influence and heal under tonic and general hygienic treatment. In the treatment of all these cases time ought not to be estimated too closely.

Fig. 538.



Hyperostosis of the Tibia.

The **deformities that follow badly united fractures** at times require surgical treatment: and when the surgeon is consulted during the first few weeks of the case, an anæsthetic should be given and the bone refractured and set in a good position, it being quite justifiable to employ considerable force to attain this end. In young subjects this refracture is rarely attended with difficulty, though in the adult it is. Œsterlen and Skey were strong advocates for this practice, the former having employed it up to the twenty-fourth week, and the latter on a boy æt. 15 thirteen months after the fracture.

When the bone has united too firmly, to permit of refracture, it should be divided by

a subcutaneous section or by some cutting operation. Key did this latter operation in the leg in 1839 (*Guy's Hosp. Rep.*, Series 1, vol. iv). The subcutaneous section should be performed in a similar way to that adopted by W. Adams in dividing the neck of the thigh-bone with a saw or chisel.

These operations, however, are to be undertaken only when the local deformity is great and the limb useless.

In the incomplete or green-stick fractures of infancy, if the bone be not straightened, strange deformities ensue. In the case depicted in Fig. 538 such a result was to be seen, the bent tibia and fibula having been much thickened by the deposition of bone in the concavity of the arch, the bone measuring across its centre six inches. It was taken from a girl twelve years old. I am now disposed to think this case was really one of hyperostosis of bone, which may or may not have followed a fracture.

SPECIAL FRACTURES.

Fractures of the Upper Extremity.

Fractures of the cranium and spinal column have already received attention; those of the lower jaw have been described in page 450, and those of the nose and sternum in Chapter XVII.

Fracture of the clavicle is generally the result of indirect violence, such as a fall upon the shoulder; and when of direct, it is usually compound or comminuted. Hamilton and Gurlt record examples from muscular action, and I have seen one in a man æt. 44 (who had had syphilis nine years before) from simply lifting a heavy weight from the ground. The bone broke near the sternal end with a snap, and a good recovery followed. The case was brought under my notice by Mr. Couling, now of Brighton, when house-surgeon at Guy's. The statistics of the Middlesex Hospital, as compiled from the experience of sixteen years by Messrs. Flower and Hulke (*Holmes's System*, vol. i. 3d ed.), prove the clavicle to be more frequently broken than any other single bone, the radius standing next in order, although, including fracture of the radius with the ulna, the fracture of the clavicle stands second. Half the recorded cases occurred in children under five years of age.

The bone, as a rule, is broken about its centre, and the line of fracture, with rare exceptions, is oblique from without inward and from before backward, the inner fragment having commonly a tendency to ride over the outer, the outer falling downward and backward.

Fractures at either extremity also occur, and one of the sternal end when vertical may be mistaken for a separation of the body of the bone from its sternal epiphysis; when oblique, downward, or upward, such an error can hardly occur.

Symptoms.—The symptoms are generally well marked. There will be inability to move the arm freely, with pain in the attempt, the patient supporting the arm of the affected side. On comparing the shoulders of the two sides the joint on the affected one will be placed lower and more forward than on the sound side, and at the same time will be drawn nearer to the median line of the body, even to the extent of an inch when the displacement is great. On passing the finger over the broken bone some depression and corresponding elevation of the broken fragments will be detected; and when the examination is made after the expiration of days, there will be also effusion of much solid material. *Crepitus* can sometimes be detected, but it need not be looked for, this symptom, with the amount of displacement, depending much upon the line of the fracture and its situation.

Dr. R. Smith of Dublin points out (*Treatise on Fracture*, 1850) how in fractures of the acromial end of the bone between the conoid and trapezoid ligaments there is scarcely any displacement of either fragment, and under these circumstances the diagnosis has to be made by the pain produced on pressure over the broken point, and by the crepitus educed by the movement of the bones in opposite directions through the fingers. He also shows how in fracture external to the trapezoid ligament, the inner fragment being drawn upward by the trapezius muscle, the displacement is great.

In children *incomplete* fractures of this bone may occur (Fig. 533).

Fractures of the clavicle are sometimes comminuted and compound, and occasionally complicated with some severe injury to the vessels beneath. In the case of the late Sir R. Peel the accident was followed by a pulsating blood tumor which was supposed to have been due to a rupture or laceration of some large vein, probably the subclavian,

while, from the severe pain that attended the injury, some of the nerves of the brachial plexus were believed to have been injured. Mr. Erichsen has recorded (*Brit. Med. Journ.*, June 7, 1873), a case in which the subclavian vein was compressed by a fragment of a broken clavicle, and in which amputation of the shoulder-joint was performed on the sixteenth day; and I have seen one in which a broken clavicle was followed by arrest of pulsation in the artery of the corresponding arm. At St. George's Hospital there is a specimen in which the end of the fractured bone was driven through the internal jugular vein.

Fractures of both clavicles have also been recorded. I have seen this more than once in children.

Treatment.—Daily experience proves that fractures of the clavicle unite without any treatment, and, moreover, palpable deformity too often shows that where treatment has been employed the union is neither perfect nor satisfactory. Daily experience likewise proves that in most, if not all, cases of fracture of the clavicle the bones fall well into place on the patient assuming the recumbent position. In young ladies, and in others where it is a matter of importance to prevent deformity, the recumbent position in bed may be maintained for about three weeks, till union has fairly taken place; but children and men will rarely be found willing to follow such a line of treatment, and happily it is not required, for nearly, if not quite, equally good results will be secured by imitating what takes place on the patient assuming the recumbent position—viz., by fixing the lower blade of the scapula to the chest, binding down its angle to the thorax, and thus preventing the tilting forward and rotation of the bone through which the deformity takes place.

The plan I have adopted for some years is to place a pad over the blade of the scapula below its spine, and to bind the bone firmly to the thorax by means of broad strips of strapping obliquely encircling half the chest from the spine to the sternum, at the same time supporting the affected arm in a sling and drawing the hand upward toward the opposite shoulder. The same method is also advocated by Dr. E. Hartshorne of Pennsylvania. Whilst the strapping is being fixed the scapula should be well tilted backward by elevating the arm, or the patient should be kept in the recumbent position. When this practice cannot be followed, the elbow should be brought forward to a point below the nipple of the affected side and the hand drawn over the opposite shoulder. The old plan of fixing the pad in the axilla and using a figure-of-8 bandage has no advantage, and, moreover, causes much discomfort to the patient.

The axillary pad of Desault is at times serviceable and may be employed, being easily fixed by a broad piece of strapping made to encircle the shoulder. In addition to the pad, Professor Gordon of Belfast (*Dublin Quart.*, 1859) recommends the injured arm to be extended downward and firmly fixed to the body by a bandage, permanent extension being kept up by means of a band fastened above to the fore-arm, flexed at right angles, and below around the perinæum or upper part of the thigh.

Sayre's method, applied as follows, is certainly valuable:

Take two strips of adhesive plaster, two and a half inches wide for an adult. Pass one strip around the arm at the junction of the lower and middle third, one end of the strip being united behind the arm to the same strip which is to be passed around the body, making a loop and leaving an open space at the posterior part of the arm. This loose loop arrangement prevents strangulation. Then draw the arm back, to bring the pectoralis major muscle upon the stretch; but the acromial end of the clavicle still rides under the sternal fragment or end. Now secure the arm back by passing the long end of the strip of adhesive plaster around the body, bringing it two or three inches under the arm of the opposite side, across the thorax, and fastening it to itself somewhere about the middle of the back. Care must be taken not to draw the arm too far back, but just sufficient to put the pectoralis major on the stretch. Then take the other strip of adhesive plaster and make a slight longitudinal slit in the centre, to admit the point of the elbow; flex the arm at an acute angle over the chest, drawing it upward, forward, and inward, and thus reduce the fracture. After bringing both fragments of the bone into a direct line, secure the arm in this position by first placing the centre of the elbow in the longitudinal slit in the adhesive plaster, passing one end of the strip across the back diagonally to the opposite shoulder, then bringing the anterior end of the strip up along over the flexed arm and the hand, over the chest, and fastening it to the posterior end of the strip at the shoulder. If this plan be carried out carefully, it will yield a perfect result without deformity.

Fractures of the scapula are probably always the result of direct violence, although a fracture of the neck of this bone may be produced by a fall upon the shoulder.

The *body* of the bone may be fissured in any direction (Fig. 539), though much displacement is rare.

In this accident mobility of the broken bone and crepitus may usually be made out by manipulation, though in fat subjects and when effusion exists the diagnosis may be difficult.

Fig. 539.

Fracture of Scapula. (Prep. 1097[2], Guy's Mus.)

Treatment.—A broad pad carefully adjusted and kept in position by means of broad strips of plaster encircling half the thorax, the arm being kept quiet and the elbow raised in a sling, is usually sufficient treatment, although a good shield of gutta-percha or felt may be sometimes beneficial.

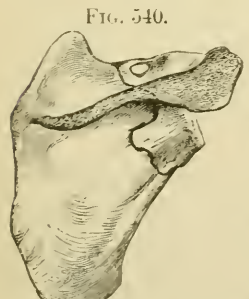
The *acromion process* may be fractured across its base or in any other part; and when it is so, the outer fragment is generally drawn downward with the arm, producing a dropping of the shoulder. The accident can readily be made out, on tracing the spine of the scapula outward, by the deformity, the break in the normal line of the bone, and the local pain, if not by the separation of the fragments. There are also loss of power in the arm and alteration in its outline.

Treatment.—It should be treated by raising the elbow by means of a good sling or bandage, a small axillary pad and a circular bandage binding the arm to the thorax. The union, however, is often ligamentous, it being impossible to keep the fragments of bone closely in apposition.

Fractures of the *coracoid process* are remarkably rare. I have seen but one decided instance, and that in a girl æt. 15 or 16, the result of a blow. There were local pain and crepitus to denote the injury, with displacement of the process, the point of which was drawn downward by the biceps muscle, and its base projecting. Dr. Pauli of Luton kindly gave me the notes of a case that occurred in a girl æt. 14 from a fall on her shoulder. There were marked mobility of the coracoid process and crepitus, but no deformity. There was pain in the part, increased by any movement of the arm. This accident is more commonly associated with dislocation of the humerus.

Treatment.—The muscles attached to the process must be relaxed, the biceps by flexing the fore-arm, and the coraco-brachialis by drawing the arm forward and inward. In this position the arm should be bound by a bandage, the bone itself, if possible, being restored to its normal position by manipulation.

Fig. 540.



Fracture of the Neck of the Scapula.

Fractures of the *neck of the scapula* or of the *glenoid fossa* must be rare. Sir A. Cooper described such cases, but since Malgaigne showed how the symptoms described might be produced by dislocation of the shoulder with fracture of the glenoid cavity, some doubt has been thrown upon the question of a simple fracture of the neck of the bone ever occurring. In Guy's Museum (Prep. 1097[3]) there is a specimen of fracture of the neck (Fig. 540), and in the Royal College of Surgeons there is a second, the third being recorded in Du Verney (*Traité des Maladies des Os*, 1751). Sir A. Cooper gives the flattening and sinking of the shoulder, the prominence of the acromion, the elongation of the arm, and the presence of crepitus as the chief symptoms, the head of the humerus being felt in the axilla. He also relates how the arm may be replaced in its normal position and again displaced on allowing the arm to drop, this symptom being the chief one of diagnosis between the supposed accident and dislocation; but when dislocation of the head of the humerus exists with fracture of the glenoid fossa, the same symptoms are found. The subject, therefore, requires further elucidation. In suspected cases of this kind the elbow should be raised, in order to press the head of the bone well upward into position, and kept there by sling and bandage.

I have seen a case of dislocation of the head of the humerus downward and forward complicated with a fracture of the lower portion of the glenoid cavity, the broken piece being drawn downward.

Fractures of the humerus form about one-seventh of all fractures, and are about half as frequent as fractures of the clavicle and scapula together. They are commonly the result of direct violence, and occasionally of muscular action. They may be divided into fractures of the *head* and *tuberosities*, *shaft* and *condyles*.

Fractures involving the *head* and *tuberosities* are usually the result of a blow or fall upon the shoulder, although occasionally they follow falls on the elbow. In a case that came under my care in 1877 and died from other injuries the greater tuberosity was crushed off and displaced upward from a fall upon the shoulder. This accident could never have been made out during life. In all cases the direction of the violence is an important point to discover, as by it the surgeon obtains the best guide to the position of the fragments as well as to the nature of the injury.

When the line of fracture follows that of the *anatomical neck*, it is intracapsular; and when this occurs, the head of the bone may be completely separated and left as a foreign body in the joint; yet such cases are very rare. In others, such as Fig. 541 illustrates, the head is separated and the tuberosity fractured; more commonly, however, the fracture is *impacted*, either the lower fragment being driven into the head of the bone or the head driven into the neck, the greater tuberosity, as a rule, being broken (Fig. 542). Dr. R. Smith of Dublin states that when this accident exists the arm is shortened, the acromion process projects, the shoulder loses its rounded form, the shaft of the humerus approaches the acromion, and the head of the bone cannot be felt. When the tuberosity is broken off, crepitus may be detected.

Fig. 541.

Fracture of the Head and Tuberosities of the Humerus. (Poland's case.)

Fig. 542.

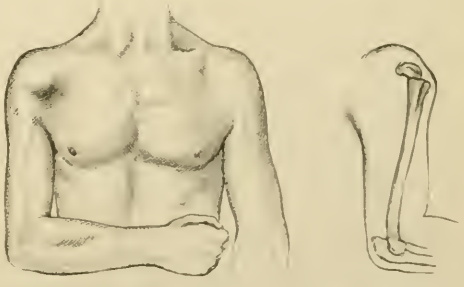
Impacted Fracture of the Head of the Humerus. (Prep. 1113ᵃ, Guy's Mus.)

In 1868 I saw such a case in a woman æt. 59 who had fallen on the shoulder nineteen days previously, the case having been treated as one of contusion. Shortening in the arm of three-quarters of an inch and a distinct prominence of bone with thickening could be felt between the acromion and coracoid processes, while the head of the bone rotated freely in the glenoid cavity. In it there was some flattening of the deltoid. A good recovery took place with permanent shortening.

I saw also a similar case in 1865, in an old man æt. 82, in which good repair took place.

More commonly a fracture about the head of the bone means a *fracture in the line or a separation of the epiphysis*, the epiphysis including the head and the tuberosities. This accident is generally the result of a fall on the elbow, and the symptoms of the accident are tolerably distinct. The head of the bone can be felt in its normal position, but is not movable on rotating the shaft, while the end of the displaced shaft is usually sent forward. When fractured, the bone presents a sharp edge and outline; but when displaced—an accident that can occur only in subjects under twenty-one—the end of the bone appears rounded and slightly convex. It is, moreover, drawn forward by the action of the pectoral muscles and made to project beneath the coracoid process in a marked and characteristic manner. In Fig. 543, taken from a male patient of mine æt. 16, this position is well seen.

Fig. 543.



Separation of Shaft of Humerus from Upper Epiphysis.

When the separation is complete, the displacement will be very marked; when partial, it will be equally characteristic; but in partial displacement of the shaft some mobility of the head of the bone will exist. In this accident the shaft may be at times replaced by manipulation, "but the moment the parts are abandoned to the uncontrolled action of the muscles the deformity recurs" (R. Smith).

When, after a separation of the upper epiphysis or fracture through the tuberosities or neck of the bone, the upper end of the diaphysis or the lower fragment of the broken bone is drawn inward and forward by the pectoral muscles, the case may simulate that of dislocation. The mistake, however, should not be made, as in the early period of the accident increased mobility of the bone and crepitus should be enough to indicate its nature, and in the later period, when the deformity produced by the end of the lower fragment is visible, the accident is palpable.

When, in fracture, impaction of either fragment exists, no crepitus will be felt unless forcible movement be made, when it may be elicited. Care, however, should be observed in seeking for this information, as a forcible separation of the impacted bones is a fatal error. The accident is generally to be made out by the nature of the injury, the shortening of the limb, the absence of crepitus, and the movement of the head of the bone on making gentle rotation of the shaft.

Treatment.—In fractures of the *anatomical neck*, when the head of the bone is driven into the tuberosity and shaft, as in all other forms of impacted fracture, union will go on if the impacted bones are not displaced by manipulation. The surgeon, therefore, has only to apply some simple splint, such as an anterior and posterior or lateral, or Stromeyer's cushion (Fig. 561), to maintain rest. The same treatment is applicable in fracture or separation of the epiphyses when the bones have been replaced. In the case illustrated in Fig. 543 a capital arm existed.

Fracture of the *surgical neck of the humerus* below the tuberosities is, however, probably the most common form of accident, and the line of fracture may be transverse or oblique (Fig. 544). In it, when the bone is broken above the insertion of the pectoral muscle—its usual seat—the lower fragment is drawn *inward* toward the chest, whilst the upper fragment is drawn upward and *outward* by the muscles that are inserted into the tuberosities. The bone projects forward or backward according to the direction of the fracture, the direction greatly depending upon that of the force. The more oblique the line of fracture, the greater the deformity. Impaction of the broken fragments may occur in this as in the last fracture, the lower usually penetrating the upper.

Fig. 544.

Fracture of the Surgical Neck of the Humerus. (Prep. 1107[37].)

Treatment.—The nature of the accident having been ascertained and the question of impaction or non-impaction decided, the treatment becomes simple; for in the *impacted* fracture, whether of the anatomical or the surgical neck, the aim should be to keep the impacted bones in position and to prevent their being loosened, so that natural processes may effect a cure in a month or six weeks with a limited degree of deformity, and in a *non-impacted* fracture the first aim is to bring the bones into as good apposition as possible and to keep them there by means of splints and position. In doing this the tendency of the fracture has to be considered, which is that the lower fragment is drawn inward by the pectoral muscle and the upper fragment outward by the scapular muscles. The best plan to carry out these objects is to fix the arm between an inside right angular and an outside straight splint, the former extending from the axilla to the wrist and the latter to the elbow, the two being well bound together. It is a dangerous practice simply to place the fore-arm in a sling and bind the arm to the side. When much injury to the soft parts or any wound exists, it is an excellent plan to draw the arm outward from the body at half a right angle and to rest it on the splint with the fore-arm partially flexed, care being taken that the lower fragment is not drawn too far inward, or to bind it on Stromeyer's cushion.

At other times a good gutta-percha, felt, or leather casing moulded to the shoulder and arm is very efficient, or a bent leather splint, the angle being well pressed into the axilla, with one half fixed to the arm and the other to the thorax.

In all these cases the surgeon should explain to the patient that some impairment of the mobility of the limb may be expected, and some shortening in impacted fractures.

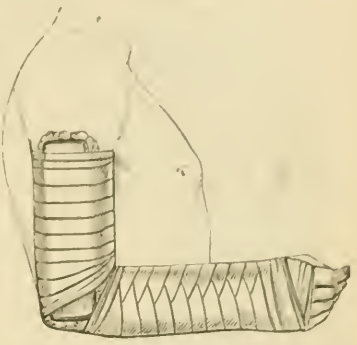
Fracture of the greater tuberosity is a recognized accident, and is usually associated with dislocation of the humerus forward, the scapular muscles drawing the tuberosity backward. Dr. R. Smith, in his excellent work *On Fractures*, gives a description of two of these cases. He describes a remarkable increase in the breadth of the articulation, the projection of the acromion and flattening of the deltoid, as the most striking features of the injury. He also draws attention to the *vertical sulcus* corresponding to the bicipital groove, formed by the head of the bone on the inner side and the displaced tuberosity on the outer, as one of the characteristic symptoms.

Fractures of the shaft of the humerus are common, and more readily made out, as well as more successfully treated, than any other fracture. When oblique, they are frequently followed by some degree of shortening; but this result is of little practical importance, as it interferes but slightly with the functions of the hand. Such fractures are as commonly the result of direct as of indirect violence, muscular action being by no means an uncommon cause. I have already mentioned an instance in which it

occurred in a man during a marital embrace, and a second produced by throwing a ball. Lonsdale, Malgaigne, Hamilton, and others have recorded similar instances.

When the fracture is transverse, there is no displacement; when oblique, the tendency of the lower fragment to ride will depend upon the line of the obliquity and its position. When the line of fracture is below the insertion of the deltoid, the upper fragment will have a tendency to be drawn outward; when above this point, the upper fragment will be attracted inward by the pectoral muscles, the lower fragment being drawn upward and outward by the deltoid.

Fig. 545.



Splint for Fracture at the Shaft of the Humerus.

Loss of power in the arm, mobility of the bone, crepitus, local pain, and deformity are ample symptoms to indicate the accident. An error in diagnosis ought not to occur.

Treatment.—This is not really difficult, although, from the fact that ununited fracture is more frequently found in this bone than in any other, it would appear as if the practice were less successful. Agnew states that out of 685 cases of non-union of bone, 219, or about 32 per cent., were of the humerus. I would explain the fact by the want of a due appreciation of Boyer's rule of treatment—viz., to keep the joints above and below the broken bone in absolute rest; for in fractures of the arm the common practice of applying splints to it and allowing perfect freedom to the action of the fore-arm is to be condemned, because in moving the fore-arm the triceps and brachialis anticus, with the biceps, have as powerful an action upon the humerus as upon the bones of the forearm.

In the primary treatment of all fractures of the arm it is a wise and scientific practice to keep the fore-arm at rest, which is best done by the application of some angular splint extending from the shoulder or axilla to the wrist, associating with it a posterior or anterior short splint reaching from the shoulder to the elbow (Fig. 545). After about two or three weeks the angular splint may be removed and some immovable one applied, the fore-arm being left free.

Any splints that secure immobility of the broken bone after its ends have been coaptated by manipulation must be regarded as beneficial, and no splints can do this effectually that allow freedom of movement of the fore-arm. When two lateral splints appear the more adapted to keep the bones in position, they must be angular, to include the elbow, and bent at a right angle.

The incomplete or green-stick fractures of children are well treated by millboard, gutta-percha, or felt splint after the bone has been restored to its normal position.

In putting up fractures of the arm care should be observed not to press upon the musculo-spiral nerve as it winds round the bone, especially when the line of fracture corresponds to its position.

Fractures involving the lower end of the humerus, whether transverse above or vertical through the condyles, or both together, whether complicated with separation of the epiphysis or some displacement of the bones of the fore-arm, are always difficult to a diagnose and to treat; and when the joint is involved, either by the fracture running into it or by displacement, there is usually some subsequent imperfection in its movement.

Fractures above the condyles, where the bone is thin and expanded, whether in the child or in the adult, or separation of the lower epiphysis (an accident of early life), are usually produced by some fall upon the elbow. When the line of fracture is oblique from behind forward, the action of the biceps and brachialis anticus has a tendency to draw the fore-arm with the lower fragment upward and forward. When the line of fracture is oblique from before backward and upward, the lower fragment of bone, with the bones of the fore-arm, is apt to be drawn backward by the action of the triceps, thereby giving rise to the external appearance of a dislocation of the bones of the fore-arm backward, since there is the same projection of the olecranon process and hollowness above it, the same projection of the lower end of the humerus forward, with the pressing forward of the artery, in both accidents. There is, however, this great distinction between the fracture and dislocation, so well expressed by Sir. A. Cooper: In fracture there is "the removal of all marks of dislocation on extension and their return as soon as extension is

discontinued;" crepitus of a marked kind is felt where a fracture is present, and of a suppressed kind where a displacement of the epiphysis exists, whereas in dislocation no crepitus is present and there is marked immobility of the bones, the bones of the fore-arm and the condyles of the humerus having lost their natural relative position. Malgaigne also pointed out that in fracture there will be a shortening between the acromion process and the internal condyle, whereas in dislocation there will be none. In fracture the anterior projection of the end of the humerus is *above* the fold of the elbow and not so broad or round as in dislocation, where it is *below* it.

Fracture of the condyles into the joint is a grave accident and likely to be followed by some stiffness of the joint. It may be oblique in any direction, the outer or the inner condyle being fractured or associated with a transverse fracture of the bone (Fig. 546). The existence of the fracture can be made out by manipulation, the amount of displacement varying with the character of the injury. Crepitus can also be detected by grasping one or other condyle and moving the broken fragment, while rotation of the radius often gives rise to it when the external condyle is involved. Flexing the ulna also produces it when the internal condyle is affected.

FIG. 546.

Right Humerus.

Comminuted Fracture of the Condyles of the Humerus. (Prep. 1112[75].)

All these fractures into the elbow-joint are rapidly followed by effusion, which often masks the symptoms and renders the diagnosis difficult and uncertain. Under these circumstances no diagnosis should be attempted until by rest and cold applications the effusion has been absorbed and a full examination can be satisfactorily made. A few days are usually enough for this change to take place. In rare cases the inner condyle is simply chipped off, the joint not being implicated. I have recently had a case of the kind in a woman in which the ulnar nerve was injured.

TREATMENT.—In all these cases of fractures involving the condyles of the humerus, whether into the joint or not, the fragments should be brought into position by extension upon the fore-arm when needed, with manipulation, and an anterior jointed rectangular splint applied, the upper half of the splint being well passed up the arm and the lower to the wrist. In some cases a posterior arm splint projecting down to the olecranon process is of use, the whole being well bound together and to the limb. The joint, as a rule, may be left exposed for external applications. Some surgeons prefer from the first an immovable casing of gutta-percha or felt, while others like lateral leather or pasteboard splints, but I think it preferable to leave the joint exposed.

In children the bones unite in about three weeks, and in adults after a month; consequently, all splints should be removed at the end of these periods and passive movement allowed. Hamilton, however, in his great work *On Fractures*, states his belief that passive movement ought to be commenced within seven days and perseveringly employed until the cure is accomplished. He does not admit the use of splints after this period, believing that the new material has steadied the fragments and that the danger of displacement is but little, while the prevention of anchylosis demands early and continued motion.

Fractures of one or other of the condyles of the humerus, complicated with dislocation of the bones of the fore-arm, occasionally occur; and when they do, they are difficult to diagnose, and more difficult to treat. In the following case the cause of the difficulty of reduction was explained by the fact that the external articular facet of the humerus had been vertically displaced and the head of the radius was in contact with the inner articular facet, whilst the ulna worked upon the internal condyle. The case was that of a boy æt. 10 who fell upon his hand, with his arm extended, from a horse's back, the force having been carried through the radius to the outer condyle. The injury was regarded at the time as one of T-fracture of the humerus. When I saw the boy, six weeks after the accident, the injury seemed to be one of dislocation of the bones of the fore-arm inward, with great thickening of the external condyle. The arm was much extended. As reduction was impossible, resection was carried out with a good result.

The preparation and drawing (Fig. 547) show that the external condyle had been broken and vertically displaced. The head of the radius and the ulna were both displaced inward and well locked by processes of bone, explaining very clearly the difficulty in reduction. The coronoid process of the ulna was in contact with the outer portion of the internal condyle, and its outer edge with the inner margin of the trochlear surface of the humerus.

The head of the radius rotated on the displaced inner half of the articular facet of the humerus, with its outer edge in contact with the displaced external condyle. The olecranon fossa was partially filled up.

Fig. 547.

Displaced and Comminuted Fracture of the Lower Epiphysis of the Humerus, with Dislocation of the Radius and Ulna Inward.

After fracture of the humerus, as of other bones, arrest of growth may follow. I have seen such an arrest of growth in the humerus of a woman to the extent of three and a half inches after a fracture of the shaft which occurred when she was about eight years of age (Fig. 548). I have also recorded (*Guy's Hosp. Rep.*, 1862) a case of a woman æt. 30 in which, with a stiff shoulder-joint, the humerus was five inches shorter than its fellow, the shortening having followed some injury to the upper part of the bone during infancy. In the first case the arrest of growth was probably due to some injury to the nutrient artery of the bone; in the second, to injury to the epiphysial cartilage at the upper part of the shaft.

Fractures of the Bones of the Fore-arm.—These form about two-fifths of all fractures, half the cases consisting of fracture of the radius alone, a fourth of fracture of the ulna, including the olecranon process, and the remaining fourth of the two bones together, fracture of the radius and ulna together being about equal in frequency to that of the clavicle.

Fracture of the radius may take place at its head, neck, shaft, or lower end. When of the neck or shaft and transverse, the fragments of bone are usually loose, yield-

Fig. 548.

Right Humerus. Arrest of Growth in the Humerus after Fracture in early life. Left Humerus.

ing on manipulation a distinct crepitus, the head of the bone being felt not to rotate in its position; but when the head of the bone is fissured longitudinally, no such symptoms will be present.

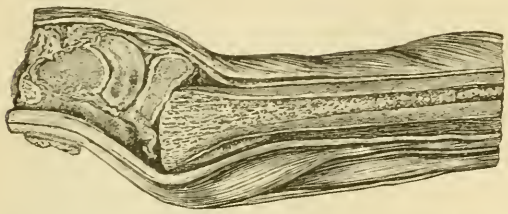
In a case of injury to the right upper extremity in a man æt. 30, complicated with brain mischief, which came under my care in 1877, there was an impacted Colles's fracture of the right radius and a vertical fracture of the head of the same bone into the joint. He had evidently fallen from a height upon his right hand and head.

Fractures of the *lower end* of the bone are of a very variable nature. They are, as a rule, caused by a fall upon the outspread hand with forcible extension backward, but they may be due to a fall upon the back of the hand with the wrist flexed. Many of them are impacted, the compact shaft of the bone being driven into the cancellated carpal extremity: and when impaction does not exist, it is frequently from comminution of the lower fragment. In possibly half of the cases of Colles's fracture, however, there is no impaction, the end of the radius being fractured and rotated backward. In young people a separation of the epiphysis backward may occur (Fig. 549).

Fractures of the lower end have always been of special interest. Colles of Dublin

first described them in 1814 (*Edin. Med. and Surg. Journal*), and such injuries are now generally known as "Colles's fracture." Dr. R. W. Smith has done much to draw attention to their nature in his work *On Fracture*, where he explains the cha-

Fig. 549.



Vertical Section of Radius, Epiphysis, and Soft Parts, showing Separation and Backward Displacement of the Lower Epiphysis of the Radius. (Taken from a boy æt. 10.)

Fig. 550.

Fracture and Backward Rotation of the Lower End of the Radius, with Impaction of the Upper Fragment. (From a patient of Mr. Lucas.)

racteristic deformity by muscular action. Figs. 551, 552 show the appearance of the wrist, with displacement of the broken end and hand backward; Fig. 553 shows fracture with displacement forward.

Callender in an able paper (*St. Barth. Rep.*, 1865) showed that Voillemier, Malgaigne,

Fig. 551.

Colles's Fracture of Lower end of Radius and Displacement Backward. (Dorsal view. From Dr. R. W. Smith.)

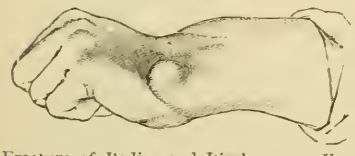
Fig. 552.

Fracture of Radius and Displacement Backward. (Side view. From Dr. R. W. Smith.)

and Nélaton's views are often correct, and that *impaction* rather than muscular action is the true explanation of the deformity.

"The radius is first broken; then, by the momentary continuance of the force in the direction of the falling body, forward and outward, the shaft is driven into the carpal end, burying itself chiefly from the dorsal surface toward the palm, and toward the outer or the inner side. In a great number of cases this impaction so fixes the fragments that they cannot be unlocked, and the deformity is permanent" (Callender). The thirty-six specimens of fracture of the lower end of the radius which the museums connected with the London schools of medicine contain clearly manifest that the cause of each deformity is the impaction of the proximal in the distal portion of the broken bone.

Fig. 553.



Fracture of Radius and Displacement Forward. (From R. W. Smith.)

Gordon, however, has demonstrated from twenty-seven specimens in the Belfast Museum that impaction is not constant. In nineteen of his examples there was oblique fracture of the bone from before backward and upward, and in eight the fracture was transverse. He believes Colles's fracture is "caused by the fall upon the palm of the hand, the fall forcing the hand backward, putting the anterior carpal ligaments and flexor tendons violently on the stretch, wrenching off by the 'cross-breaking strain' the lower end of the radius, tilting it backward, with alteration of the aspect of its carpal surface, and the bearing of the carpus upon it, leaving a gap between the fragments in front." He likewise thinks that fractures produced by a fall on the back of the hand with the wrist flexed are often impacted.

The fracture is usually placed about half an inch or an inch above the wrist-joint, and the lower fragment or epiphysis is displaced backward. It is, moreover, so displaced that the articular facet, instead of looking downward, forward, and inward, is made by rotation to look downward, backward, and outward. The outer side of the fracture toward the styloid process is rotated more than the inner, the strong ligaments uniting this with the ulna holding the bone more in position. On this account the lower fragment is often also broken vertically, giving rise to greater deformity as well as to shortening of the bone on its outer border. In rare examples the fracture of the radius is complicated with dislocation of the scaphoid bone forward. Dr. Cameron (*Glas. Journ.*, March, 1875) of Glasgow, and Mr. Knott (Surg. Soc. of Ireland, January, 1881) of Dublin, both give examples of

this. In some cases the end of the bone is comminuted (Guy's Museum, 1119[4]), and Fig. 554 illustrates a case of fracture of both radii from a fall on the hands.

Diagnosis.—The diagnosis of this accident is not difficult; indeed, the aspect of the wrist may be said to be characteristic. "The posterior surface of the limb," wrote Colles, "presents a considerable deformity; for a depression is to be seen in the fore-arm about an inch and a half above the end of the bone, whilst a considerable swelling occupies the wrist and metacarpus; indeed, the carpus and base of the metacarpus appear to be thrown backward so much as on first view to excite a suspicion that the radius has been dislocated forward. On viewing the anterior surface of the limb we observe a considerable fulness, as if caused by the flexor tendons being thrown forward; this fulness extends upward to about one-third of the length of the fore-arm, and terminates below at the upper edge of the annular ligament of the wrist. The extremity of the ulna is seen projecting toward the palm and inner edge of the limb." (*Vide* Fig. 549.)

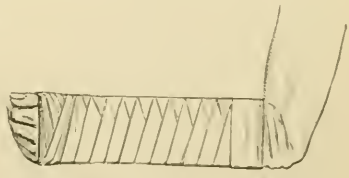
Fig. 554.

Fractured End of Radius and Styloid Process of the Ulna (Prep. 1158[2]).

The amount of deformity turns upon the amount of displacement of the broken fragments. There will be pain in the part, increased by pressure on the seat of fracture, and about the internal lateral ligament, the movement of the joint being rendered impossible. On feeble movement of the hand the head of the radius will be felt to rotate when the fracture is an impacted one; crepitus will be either absent or very indistinct, and can only be well brought out by loosening the broken bones. In rare cases these fractures are compound, the end of the shaft of the radius projecting forward. More commonly, however, the ulna is made to protrude. Both these conditions existed in the case from which Fig. 560 was taken.

Treatment.—In all fractures of the radius it is essential to keep the hand at rest, and, as a consequence, all splints should extend at any rate down to the base of the fingers. In fractures of the neck or shaft the elbow should be bent at right angles and the hand held midway between pronation and supination, two well-padded broad splints extending down to the fingers being firmly fixed on by strapping, broad bands, or a roller (Fig. 555). When, as in fractures of the shaft, there is a disposition for the fragments to fall inward, some extra pad may be employed.

Fig. 555.

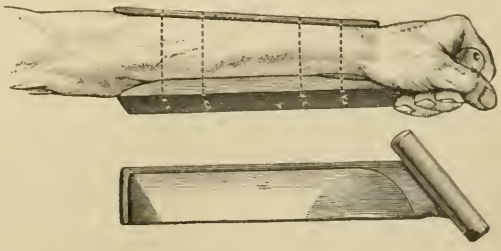


Splints for Fracture of Fore-Arm

The splints should be removed after three weeks and freedom given to the hand, movement of the muscles being encouraged; shorter splints or some immovable apparatus should also be substituted down to the wrist whilst union is being consolidated. Lateral pressure of the bandages must always be avoided.

In fractures of the lower extremity of the radius the old-fashioned pistol-shaped splint is still in favor with some, its object being to keep the hand and wrist adducted, and thereby to counteract the deformity that so commonly attends this form of fracture. Some surgeons, and more particularly the American, apply it to the palmar, and others, including Nélaton, to the dorsal, aspect, with a shorter second splint. I am no believer in its virtues: for if the fracture be impacted and the fragments are not loosened, it is useless, as union has only to go on between the impacted fragments for a cure to be effected; and when the fragments are loosened and the bones brought into apposition by extension and manipulation, the pistol splint is not wanted; indeed, it is probably injurious, causing displacement of the broken bones. A well-padded broad anterior splint reaching to the roots of the fingers, with a dorsal splint, answers every purpose, the wants of the individual case determining the amount and position of the extra padding. The best splint is without doubt that known as Carr's splint (Fig. 556).

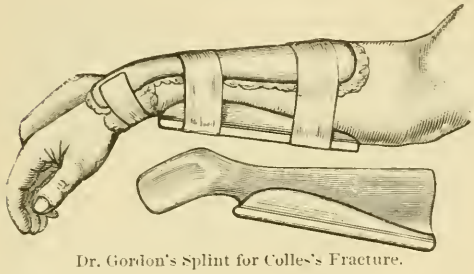
Fig. 556.



Carr's Splint.

It is about eleven and a half inches long and two inches wide. The anterior portion has an irregular convex surface, to fit into the concavity of the lower side of the radius, and the posterior is flat; connected with the anterior an oblique cross-bar four inches long is fixed for the patient to grasp. When padded and nicely fixed with strapping or a bandage, it is efficient and comfortable.

FIG. 557.



Dr. Gordon's Splint for Colles's Fracture.

Dr. Gordon of Belfast has introduced a splint that has found favor. It "consists of the body, the ulnar and bevelled portions, with a curved back splint (Fig. 557). The lower end of the ulnar portion is curved forward and hollowed, to receive the inner border of the flexed hand, with a slit for the carpal strap. The bevelled portion is secured to the body of the splint nearly half an inch internal to its margin; it is cut off obliquely from without inward and from below upward; it is applied to the palmar surface of the upper fragment, which it is its office to fix. The lower end of the back splint is much curved forward. This curve, with a thick pad, is necessary to enable it to press the base of the metacarpus, the carpus, and the lower end of the lower fragment *well forward* for the restoration of the natural aspect of the carpal surface and the concavity of the radius" (*Gordon on Fractures of Radius*, etc., p. 24, 1875).

The fore-arm should be well supported by a sling.

After this form of fracture the wrist-joint rarely recovers its normal movement, some deformity permanently remaining; and of this the patient ought to be warned. I have recently, however, had under care (June, 1878) a case of double compound Colles's fracture in which a recovery took place without any deformity.

Fractures of the ulna are almost always the result of direct violence, the middle and lower parts of the shaft—the thinner portions—usually suffering. In these cases there is, as a rule, little displacement: and when it exists, it is of the lower fragment. On manipulation crepitus is usually present, with local pain. Fracture of the *olecranon* process is a very frequent accident from a fall or blow upon the elbow or a sudden action of the triceps. In it there is always more or less displacement of the end of the process; and the smaller the piece, the greater the displacement, the base of the process being held well in position by the fascia covering the bone and the periosteum. Fracture of the *coronoid* process (Guy's Museum, 1119[25]), with or without dislocation of the ulna backward, has also been described, though very rare. In the case from which Fig. 559 was taken it coexisted with fracture of the head of the radius. The styloid process of the ulna may likewise be broken and displaced forward or backward, and is generally caused by a fall upon the hand; it is, consequently, a frequent accompaniment of Colles's fracture.

TREATMENT.—In fractures of the shaft the treatment is simple, the radius acting as a splint and preventing shortening. The surgeon has only to see that the broken bone is kept quiet and that the fragments are in position. This is well done by means of well-padded anterior and posterior splints, the hands being fixed in a position midway between pronation and supination, Carr's splint being the best.

In fractures of the *coronoid* process the fore-arm should be kept flexed, to relax the brachialis anticus muscle, which is inserted in it, and in fractures of the *olecranon* nearly *straight*, to relax the triceps, through which the separation of the fragments takes place. The splint may be strapped on or fixed by strapping, and in severe cases an immovable apparatus is advisable.

Some separation of the fragments very frequently remains after fracture of the olecranon, which increases when the arm is used too soon, the power of the arm being consequently weakened. Passive movement of the arm, however, should always be permitted about five weeks after the accident, all violent efforts being condemned.

Fracture of both radius and ulna occurs about as frequently as fracture of the ulna alone, but not a quarter so often as fracture of the radius. *Direct* violence is the usual cause, a fall upon the hand being more commonly followed by fracture of the radius than by that of the two bones.

Malgaigne has recorded instances of this accident from muscular action. In infants the *green-stick* or *incomplete* fracture of both bones is not infrequent.

The fracture may be transverse, oblique, or comminuted, and the displacement of the

fragment may vary vastly according to the direction and violence of the force which produced it.

These fractures are readily made out and not often difficult to manage, although at times the surgeon's ingenuity is taxed to prevent deformity.

Treatment. — Under all circumstances the fore-arm should be flexed and the hand kept in the semi-prone position. Two *wide* splints should be employed, well padded, broad, and coming down to the roots of the fingers, the surgeon so arranging his pads as to prevent deformity and to neutralize the peculiar tendency of the fracture. When the parts are bandaged too tightly, the bones may be pressed together, and consolidation takes place as a whole, with consequent loss of motion, or the two bones may be braced together by some bony isthmus (Fig. 558). *Under all circumstances the fracture should be put up with the hand supinated*, the dorsal splint being first applied, and then the palmar, the fore-arm being semiflexed. When fracture of the radius and ulna takes place above the wrist-joint, the symptoms may simulate those of dislocation; but the greater mobility of the lower ends of the bones, crepitus, and local pain ought to forbid the error being acted upon.

Fig. 558.

Radius and Ulna Consolidated after Fracture. (Prep. 1119[a]).

Fracture of the carpal bones can occur only from direct violence, some crushing force being the usual form. It may be difficult to diagnose, as the same force that produced the fracture will to a certainty have injured the soft parts around the bones. Happily, however, the treatment of any severe injury to the wrist should be such as will serve for all; for the application of an anterior splint, as well as cold lotions and absolute rest of the injured part, ought always to be observed in all clear as in doubtful cases, and with these a good result may generally be secured.

Fracture of the metacarpal bones is not rare. It is commonly caused by some blow when fighting or other form of direct violence. Thus, it is most frequent in the right first and fifth bones. Dr. E. H. Bennett of Dublin has shown (*Dub. Journ. of Med. Sci.*, January, 1882) that in the commonest form the fracture passes obliquely through the base of the bone, detaching the greater part of the articular facet and allowing the body of the bone to be displaced with the thumb backward. It is rarely complicated with much displacement. In young subjects the head of the bone or epiphysis may be displaced. It should be treated, as all fractures, "with brains," the pads and splints being so applied as to fulfil the wants of the individual case. In the majority a simple pad placed on the palm, with an anterior splint, may be sufficient. In one case Malgaigne's plan of placing a thick compress under the head of the bone and a second over the dorsal projection, with two broad splints across the hand, may be called for; in another Sir A. Cooper's, of binding the flexed fingers over a ball, may fulfil the necessary requirements; but, as a rule, an anterior splint and palmar pad carefully adjusted supplies every want and is sufficient, the surgeon remembering that the palmar surfaces of these metacarpal as well as phalangeal bones are concave.

Fracture of the phalanges is usually compound, although it may be simple, and is easily diagnosed and readily treated. A simple anterior splint is all that is required, a dorsal being rarely called for, a piece of wood serving for the purpose, though a thin piece of perforated zinc is preferable. The splint should be fixed on with strapping, a coating of the compound tincture of benzoin rendering all firm and immovable.

Fig. 559.

Fracture of the Coronoid Process and Head of Radius, produced by a Fall upon the Elbow. Taken from a woman æt. 70.

In **compound fracture into the elbow-joint**, when the parts are much injured, excision is probably the wisest step to adopt, as by it convalescence is hastened and a good arm with a movable joint, as a rule, given, whereas a recovery by natural processes without operation will probably end with anchylosis after a tedious process of suppuration. When the injury, however, is not severe and the patient young, excision is not called for, a recovery with a movable joint being possible. I have had several excellent examples of this under my care during the last few years. In aged subjects, however, amputation may be required, and in the one from which the preparation (Fig. 559) was taken such a step was demanded. The drawing illustrates an uncommon form of accident—comminuted fracture of the head of the radius and fracture of the coronoid process.

Compound fractures of the arm and fore-arm ought to be treated upon

the same principles as the simple—that is, when the injury is not sufficient to necessitate amputation or excision the bones should be brought into apposition and kept there by means of splints, interrupted or not, the wounds being covered either by lint soaked in blood, or, what is better, by the compound tincture of benzoin. It may be added that the injury should indeed be great to necessitate amputation, it being justifiable to incur some extra risk to save the hand.

In a severe case of compound comminuted fracture of the humerus caused by the passage of a rifle bullet through the bone in a young man, which came under my care at Guy's, good success attended the immediate sealing of the wound with benzoin and the application of the splint. The man left the hospital in three months with a firmly-united bone and a good sound arm. In such a case as that represented in Fig. 560, where displacement of the lower epiphysis of the radius and dislocation of the ulna existed, amputation was demanded.

Fig. 560.

Compound Dislocation of Ulna and Shaft of Radius Forward, with Displacement of the Lower Epiphysis of the Radius Backward.

Fig. 561.

Stromeyer's Cushion (from MacCormac). With straps applied.

I have little to add to what has already been given in the way of treatment of compound fractures of the humerus beyond an allusion to Stromeyer's cushion, which commends itself to attention as much by the eminence of its advocate as by its usefulness. It was introduced to our notice by Sir William MacCormac (Fig. 561).

The cushion may be described as triangular and wedge-shaped. At its thickest end it measures four inches in depth, and from this point gradually thins down for a length or fourteen or fifteen inches. The elbow rests on the thick end, while the thin rests on the side of the chest. The cushion is readily fastened in its place by a tape round the neck and the body; and when this simple apparatus is applied the arm rests beautifully supported and in excellent position. Whilst lying in bed nothing beyond the ordinary dressings are required for the wound; and if the patient has to be transported from one place to another or is fit to walk about, this can be arranged with the utmost facility, as cushion, arm, and all can be bound by a broad bandage to the body and thus form an immovable whole. Stromeyer considered this cushion to be "the most valuable appliance he had invented during his life." I have used it for fracture and dislocation of the humerus and for shoulder-joint disease with great advantage, and have adapted straps to it to hold the arm and fore-arm in position.

Compound dislocation and fracture of the phalangeal joints require a distinct consideration, and the slight constitutional symptoms which such injuries induce enable the surgeon to treat them on purely local considerations.

To dwell on the importance of the integrity of the hand as a whole or to adduce arguments to show the necessity of saving as much as possible of the thumb and fingers is unnecessary, since these rules of practice are now acknowledged; yet such have their limit, as anchylosis of some of these joints may prove an impediment rather than an advantage to the free use of the hand, and a stiff finger to a man in one business may be most detrimental, while to one in another, if bent, it may be of service.

With the thumb, however, the above rule may be considered absolute, and an attempt should invariably be made to save the joints and as much as possible of the injured parts, it being often better in compound fractures to leave the bone to granulate than to remove it; for the use which may be made of the stump of a thumb or of one fixed by anchylosis can be appreciated only by those who have been fortunate enough to witness such instances.

With the fingers this rule will not hold so good, since it often happens that the loss of a finger will be found of less inconvenience than a stiff one. In a general point of view, a stiff metacarpo-phalangeal joint to a laboring-man is an impediment, while to a gentleman it may be of service and at the same time preserve the comeliness of the part. A

stiff first phalangeal joint will be most prejudicial in some trades, while in others it is of slight importance. A stiff joint between the extreme phalanges is rarely of much moment.

The patient, however, should be consulted by the surgeon in all these cases and the treatment adapted to the wants of the individual, since a position that may be good for one may be bad for another, and no one position is applicable to all. It is too common to find men applying at London hospitals to have fingers removed that have been saved, but fixed at bad angles, the stiff finger being an impediment to the free performance of their trade.

In compound fractures and dislocations of the thumb loose fragments of bone should be removed and joints excised; as much as possible of the soft parts should be saved and the wound left to natural processes for repair. To amputate a thumb for injury ought to be a very rare operation. In these injuries to the fingers the same principles of practice should be adopted, although modified by the wants of the individual case. To save a finger and to amputate it months after on account of some stiffness of joint or malposition is to waste time. When a joint has been opened and anchylosis must be looked for after a natural recovery, the propriety of making the attempt should be discussed before the practice is decided upon, when, if the decision be in favor of a conservative practice, the injured parts should be adjusted and fixed by means of a splint in the most favorable position.

In most subjects the straight is a forced and inconvenient position, and not that ever assumed by nature with the hand at rest. The best is the slightly bent, when the thumb and fingers can touch at their tips, or that which the hand naturally assumes when at rest. In exceptional cases, however, exceptional positions may be required. I have for years acted upon this principle, and always with advantage.

The best splint for fingers is a piece of perforated zinc. It is thin and can be bent to the required curve without trouble, as well as readily fixed on with strapping or lint saturated in tincture of benzoin.

Fractures of the Lower Extremity.

Fractures of the pelvis, as of the cranium, spine, and thorax, are of importance, inasmuch as the visceral contents are involved; but when no such complications exist, the injury is, comparatively, not dangerous.

Fracture and dislocation of the bones commonly occur together and may be regarded as alike in a clinical point of view.

The **anterior portion of the crest of the ilium** is not rarely broken from direct violence, and the accident is not serious. Rest in bed, to keep the abdominal muscles quiet, and the application of a pad with strapping, a mould of gutta-percha, or a broad pelvic belt when displacement exists, are the ordinary surgical means required.

Fracture of the pelvic basin itself is usually the result of some crushing force, the weakest part breaking, such as the rami of the pubes. In other cases there will be some separation of the pubic bones at the symphysis or other fracture of the brim. In many the injury will be complicated with laceration of the urethra. In the case of a female æt. 30, which I had under care, the bones were displaced on the right side for more than an inch, when a curious deformity resulted, the pelvic bones with the adductor muscles being curved out, leaving a hollow on the inner side of the thigh.

In another, sent to me by Dr. Bennett of Builth, in a female child, great separation of the pelvic bones was present, the whole pelvic organs having been pressed out of the outlet of the pelvis by the crushing force. The large intestine for about a foot, uterus, bladder, etc., were all in view, the whole perinæum having been ruptured. The drawing (Fig. 562) shows the child's condition when I saw her fourteen months after the accident. How the child escaped with life was a mystery, the perinæum being gone, the bowels protruding, and the bones of the pelvis widely apart. Such a case is enough to show how great an injury the pelvis may occasionally sustain without causing death. As an example of fractured pelvis Fig. 563 may be referred to.

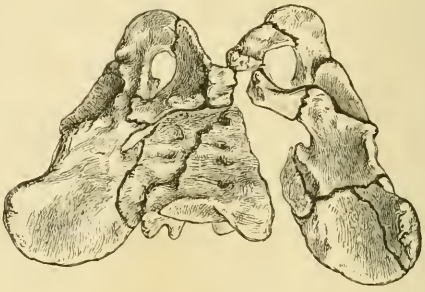
Diagnosis.—The greatest care is necessary in examining the subject of a suspected fracture of the pelvis, yet the diagnosis can generally be made from the nature of the force employed, its direction, and the complications that exist. Urethral complication is the most common in the male, and ought to be treated as already described at p. 698. As an illustration of the practice there recommended, in June, 1875, a boy æt. 7 was admitted under my care into Guy's Hospital with fracture of the pubic bones and

laceration of the urethra, accompanied with profuse hemorrhage and retention, for which catheterism was ineffectual, and death seemed imminent. I consequently made a free incision into the perinæum down to the lacerated urethra upon a grooved staff, and a rapid recovery took place after. Under all circumstances the utmost quiet must be enforced; for if the surgeon is unable to restore the fractured bones to their normal posi-

Fig. 562.

Fracture of the Pelvis in a Child, with Separation of Pubes, Prolapse of Rectum and Uterus.

Fig. 563.



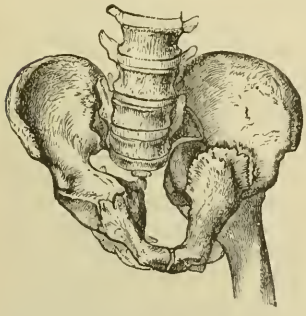
Fracture of Pelvis.
(Prep. No. 1134, Guy's Hosp. Mus.)

tion, at any rate he must do nothing to render their displacement greater or to increase the risk of visceral injury. Where support by means of a bandage, strapping, or casing of gutta-percha or some other substance gives comfort or seems called for, it should be applied; but in general absolute rest and such treatment as the complication may require are all that is necessary. In two cases I have seen obstruction of the iliac artery associated with fracture of the brim of the pelvis. In one the vessel was so stretched as to cause laceration of its inner and middle coats and obstruction, which were followed by gangrene of the corresponding limb. In the other the obstruction lasted three weeks, when pulsation returned and the patient recovered.

Fracture of the acetabulum from the head of the femur being driven against the bone has been recorded. Earle, in the nineteenth volume of the *Med.-Chir. Trans.*, adduced a case in which the pelvis was broken into its three anatomical portions. Sir A. Cooper and Travers have recorded others. Moore, also, in the thirty-fourth volume of the same *Transactions*, has given another, with a drawing, as figured here (Fig. 564). When the head is driven into the pelvis, as illustrated in the drawing, there will be deformity of the hip, inability to move the limb, with pain in the attempt, and crepitus. Travers believed that acute pain on pressure upon the projecting spine of the pubes and inability on the part of the patient to maintain the erect posture after pelvic injury are diagnostic of *fissure of the acetabulum*.

A fracture of the *lip of the acetabulum* is probably present in such cases of dislocation of the hip as become displaced again after reduction, the head of the bone, having nothing to restrain it, slipping out of its cup. In these cases the reduction of the dislocation is usually attended with crepitus, followed by redislocation on the removal of the extending force. It should be treated by fixed extension, as in fracture of thigh-bone, and some circular pelvic pressure. This accident is more frequently associated with dislocation of the head of the femur backward than with any other.

Fig. 564.



Head of Femur driven through Acetabulum. (*Med.-Chir. Trans.*, vol. xxxiv.)

Fracture of the sacrum may be regarded clinically like that of the pelvis; it is always the result of direct violence.

Fractures of the Lower Extremity.—From hospital statistics these fractures appear to be more common than those of the upper extremity; but, as the majority of cases of fracture of the upper extremity are treated as out-patients, of which no records are kept, the conclusion is weakened by a fallacy. The Middlesex Hospital statistics, compiled by Lonsdale and H. Morris for sixteen years, tell us that there are 1206 examples of fracture of the lower extremity to 1932 of the upper, proving that fractures of the upper extremity are twenty-three per cent. more frequent than those of the lower.

Fractures of the femur form about one-fourth of all fractures of the lower extremity, and fractures of the neck about one-fifth of the fractures of the bone. They may be divided into those (1) of the *neck or upper end*, (2) of the *shaft*, and (3) of the *lower or condylar end*.

Fracture of the neck or upper end existed in 14 out of 217 consecutive cases admitted into Guy's, or in one-fifth of all cases. It is more frequent in the old than in the young, probably from the impaired nutrition of the bone, the cortex in the aged being always thinner and the cancelli larger. I have, however, seen it in a boy æt. 12 and a man æt. 27. Stanley and Hamilton have recorded examples at even an earlier age. In Guy's Museum there is a specimen taken from a child æt. 9 (Prep. 1184).

When the fracture involves the neck near the head of the bone, it has been called *intra-capsular* (Figs. 565 and 570); when the base of the neck near the trochanters, *extra-capsular*; but in these the joint is generally involved, the line of fracture, as a rule, being oblique from the neck within to the base of the neck without the capsule. Both forms may be impacted; the former is so frequently, the latter generally.

Fig. 565.

Intra-Capsular Fracture of the Neck of the Femur, showing Ligamentous Repair.

In the fractures of the neck near the head of the bone the neck of the bone is usually driven into the head (Fig. 570). In the fractures of the base of the neck the neck is, as a rule, driven into the shaft (Figs. 535, 566, 567). In exceptional cases the impaction is double (Fig. 571).

Fractures of the narrow part of the neck of the femur are generally caused by *indirect* violence, such as tripping in the carpet; fracture of the base of the neck by *direct*, such as a fall upon the trochanter. When the *posterior* ridge of bone penetrates the trochanter, there will be eversion of the foot, the outer surface of the trochanter looking backward, and the anterior surface of the neck will be felt as a prominent projection beneath the rectus muscle. When the *anterior* ridge of bone penetrates the lower fragment, the foot will be straight or inverted, the surface of the trochanter will look outward, and a great fulness will be felt behind the trochanter. Should the limb be much *adducted* when the patient falls upon the trochanter, the lower border of the neck may be driven into the trochanter, as seen in Figs. 535, 566; and should the limb be much *abducted* when the fall takes place, the fracture will probably be in the narrow part of the neck, and therefore unimpacted and intra-capsular. When the penetration of the neck is great, the trochanter will be broken off and there will be no impaction, but the usual unimpacted fracture of the neck.

With these facts before us, the best division of fractures of the neck of the femur for practical purposes seems to be into the *impacted* and *unimpacted*.

Sir A. Cooper recognized this fact of impaction to a degree, though he did not quite see its importance, when, in describing fractures of the upper part of the thigh-bone he wrote, "The fracture is placed at the root of the neck of the thigh-bone, the trochanter is split, and the neck of the bone is received into its cleft. It frequently happens in this injury that the fracture of the neck of the thigh-bone is complicated with an injury of the trochanters, major and minor; the neck of the thigh-bone is forced at times into the cancelli of the major trochanter." To the late Professor R. W. Smith of Dublin the thanks of the profession are unquestionably due for having given prominence to this class of cases, and in his valuable work on fractures in the vicinity of joints, published in 1850, will be found nearly all that is known about the subject.

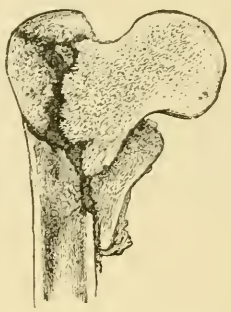
I am fully prepared to endorse his opinions and to agree with him "that all extra-capsular fractures are in the first instance also impacted fractures." I believe, moreover, that many so-called intra-capsular fractures and all mixed forms are primarily of a like kind, and "that it depends principally upon the violence with which the injury has been inflicted whether the neck of the bone shall remain implanted between the trochanters, or whether these processes shall be so completely separated from the shaft of the femur as to allow of the escape of the cervix from the cavity which it had formed in the reticular tissue of the lower fragment. If the force had not been very great, the neck of the femur remains wedged in between the trochanters and one or both of these processes are split off from the shaft; and if the fibrous structures around the neck of the bone and trochanters have not been injured, these broken portions of the trochanters are still held firmly in their places and the cervix does not become loosened (Fig. 566); but if the force has been considerable, the impulse prolonged, the bone in a state of senile atrophy,

or if, as frequently happens, the patient in endeavoring to rise falls a second time, then, under these circumstances, the trochanters are not only broken from the shaft of the femur, but are so far displaced and separated from their connection with the soft parts that the cavity or socket, as it were, into which the superior fragments has been received, is destroyed; the impacted cervix thus set free no longer opposes the ascent of the inferior fragment, and the case then presents the characters of the ordinary extra-cap-

Fig. 566.

Impacted Fracture of the Neck of the Thigh-Bone. (From the museum of my father, the late Mr. T. E. Bryant. Prep. Guy's Mus., 1187[55].)

Fig. 567.



Comminuted Fracture of the Upper Part of the Thigh-Bone from the Neck being driven into the Shaft. (Prep. 1194, Guy's Mus.)

sular fracture with great shortening of the limb" (Fig. 567). In fact, the ordinary fracture of the base of the neck of the thigh-bone is primarily an impacted fracture, the impacted bones in some cases being loosened by a second fall, in others by excess of violence received in the original accident, and *in too many by the manipulation of the surgeon in his anxiety to make out the presence of a fracture by the detection of crepitus.* Indeed, this seeking for crepitus in cases of fracture is a practice fraught with danger. In fractures of the neck of the thigh-bone it is not only unnecessary, because the diagnosis of the case can be made out without it, but it is unjustifiable, as the attempt to find it in every case of impacted fracture is often attended with irreparable mischief.

Symptoms.—The diagnosis of fracture, impacted or otherwise, is a point of considerable importance, but that of an impacted fracture is particularly so, since it is not to be disputed that the recovery or degree of lameness of many a patient depends upon a correct appreciation of the value of such symptoms as usually exist in this variety of fracture, and that, too, in a very critical period of the case. Should an error in diagnosis be made and the case being one of impacted fracture be overlooked, violent manipulative efforts will probably be made to reduce the supposed dislocation or to set the supposed fracture, or, what is equally probable, to decide the question between the presence of the two by the detection or non-detection of crepitus. As a consequence of this violence the impacted bones will to a certainty be loosened, if not worse disturbed, and the case will be changed from one in which the bones were placed favorably for union and recovery into another in which a very different set of circumstances has to be encountered and a less favorable prognosis has to be given.

Fig. 568.

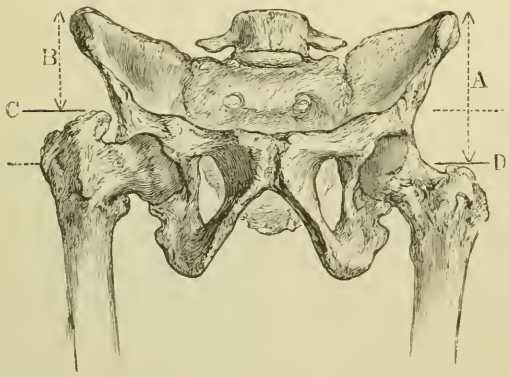


Figure showing how the Trochanter of the Fractured Bone is Drawn Upward nearer the Anterior Superior Spine of the Ilium. A, Normal length of base of ilio-femoral triangle (Fig. 569). B, Shortened base of ilio-femoral triangle. C, Horizontal level of fractured bone. D, Horizontal level of sound bone.

Happily, however, the diagnosis of these cases is not difficult, and the symptoms that indicate the presence of an impacted or non-impacted fracture are fairly characteristic. Those of an ordinary non-impacted fracture of the neck of the thigh-bone in any position are some slight indirect or violent direct force; a *shortening* of the limb from one to two and a half inches; *rotation outward* of the limb, with eversion of the foot from mere gravity; inability *to raise the*

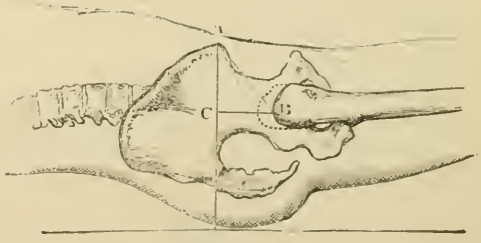
limb on the part of the patient, but greater movements of the limb by the surgeon's hands; *swelling*, according to the character of force employed and time after injury; *pain* and occasional *crepitus*. In rare cases of non-impacted fracture of the neck the foot may be inverted and the thigh even flexed. Those of an impacted fracture are a blow or *fall upon the trochanter*, followed by a more or less complete *loss of power* in the limb; *shortening* to the extent of half an inch or one inch; a *fixed*, *everted*, *inverted*, or *straight* position of the foot, which moderate extension will *not* rectify: and when the impaction is great, an approximation of the great trochanter to the median line of the body (Fig. 568). The head of the bone will rotate in the acetabulum, and the trochanter with it, the rotation, however, of the trochanter taking place through an arc of a circle of which the head of the bone is the centre, instead of upon the axis of the shaft, as in detached fracture of the neck. There will be indistinct or no crepitus. Local pain will always be felt on pressure behind the trochanter, and local thickening within a few days of the accident.

When, from the direction of the force applied to the trochanter, the *posterior* wall of the neck is driven into the inter-trochanteric line, the limb will be rotated outward and the foot *everted*; and when the *anterior* wall is driven into the bone, there will be *inversion* of the limb. The former form of accident is far more common than the latter, on account of the greater thinness of the posterior wall.

To make out the existence of shortening of the neck of the thigh-bone and its amount, Nélaton's line is most inconvenient, since it necessitates the semi-rotation of the patient over toward the sound side, and consequently it includes the risk of causing displacement of the bones. My own test-line has no such objection and can be applied to the patient in the horizontal posture. I have used it for many years and found it of great value; indeed, as a proof of its use I may add that forty-two consecutive cases of fracture of the neck of the thigh-bone admitted into my wards to the end of 1883 (the average age of the patients being seventy) left the hospital with union of the broken bones and useful limbs. Only one patient, æt. 79, died, and she did so with the fracture, though not from it, but from sloughing of the skin in her lumbar region from injury sustained at the time of the accident. In two only of the forty-two cases was there any bedsore, and these gave no trouble. All were treated with the double splint (Fig. 573). The diagnosis of all these cases had been made by means of the test-line I now describe, and with the gentlest manipulation (*Lancet*, January 22, 1876).

For purposes of demonstration I have described it as the base of the ilio-femoral triangle (C B, Fig. 569), the two sides of the triangle being made up of two lines drawn from the anterior superior spinous process of the ilium, one of them, A C, being vertical and traversing the outside of the hip to the horizontal plane of the body, and the second, A B, impinging on the tip of the trochanter major and corresponding in the normal condition of the hip-joint to the anterior half of Nélaton's test-line for dislocation of the head of the femur backward.

Fig. 569.



The Ilio-Femoral Rectangle, A B C. C B, test-line for fracture or shortening of the neck of the thigh-bone.

The test-line C B for fracture or shortening of the neck joins the two at *right angles* to the vertical line and extends from it to the trochanter. Any shortening of this line, on comparing it with the same taken on the uninjured side, indicates with precision a shortening of the neck of the thigh-bone; and when the shortening has immediately followed an injury, fracture of the neck of the thigh-bone, impacted or otherwise, is certain. Compared with this line, all other measurements are uncertain. By its use manipulations of the injured limb are rendered unnecessary. For practical purposes the vertical line A C and the test-line C B are alone required. To compare the two sides of the body it is necessary to see that the pelvis is straight.

My friend Mr. H. Morris has likewise a ready method of measuring those parts, which he calls the bi-trochanteric measurement. (See *Holmes's Syst.*, vol. i. 3d ed. p. 1003).

The symptoms thus described, taken as a whole, may be looked upon as pathognomonic of an impacted fracture: for, although there are other injuries to the hip-joint which may give rise separately to many of the symptoms detailed, there are none in

which all or most are found combined. There is no injury to the hip-joint in which the head of the femur rests and can be made to rotate in the acetabulum, and in which *immediate shortening* is ever found, with the exception of a fracture, and there is no form of fracture that occurs under like circumstances, with the exception of the impacted, that is not accompanied by crepitus that can be readily detected, with complete eversion of the foot, marked shortening, and loss of power over the limb.

These points are well brought out in a paper in the *Med. Times* of 1869, in which I gave a careful analysis of fourteen cases.

When sudden increase in the amount of shortening takes place some days after an injury to the hip, the separation of the impacted bones and the drawing up of the lower fragment should be suspected; and when some gradual shortening follows, it signifies the absorption of the injured neck of bone.

The eversion of the limb, as found in the non-impacted fracture, is due to the simple weight of the broken limb, aided by the action of the powerful external rotator, and possibly of the adductor, muscles. The position of the limb in the impacted fracture, whether slightly everted, straight, or inverted, is determined by the impaction of the anterior or posterior wall of the neck, and by the fact that the foot will be fixed by the impaction in the position in which it existed at the time of the accident.

In non-impacted fracture of the narrow end of the neck, or true intra-capsular fracture, there is usually less shortening than in the non-impacted fracture of the base, this symptom depending in both of these cases upon the amount of separation of the fibrous covering of the broken bone. In the former crepitus is also less distinct. In both these forms the shortening will be made to disappear by extension, whilst in the impacted, in any of its varieties, no such effect will be produced by ordinary force.

It can only be by carelessness that a contused hip is mistaken for a fractured thigh, impacted or otherwise. I have, however, known this error to be committed.

"The practical importance of readily identifying this fracture," writes Bigelow in his valuable monograph on the hip, "lies in the fact that its progress, as regards both time and good union, is in general more favorable than that of the unimpacted fractures; that, though it is a comparatively common and disabling accident, it may exhibit little deformity; and lastly, that the object of extension in its treatment is to steady the limb, and not to draw it down."

TREATMENT.—If it were as distinctly understood as it should be by all students and practitioners that a fracture of the neck of the thigh-bone can be diagnosed without seeking for crepitus, that all but the gentlest manipulation of an injured hip is likely to prove injurious, and that any attempt to elongate the limb by forcible extension, to flex it, or to rotate it with the view of restoring it to its natural position is likely to be followed by a breaking up of the impacted bones, and consequently by irreparable injury, the treatment of these cases would be as satisfactory in its results as it is simple and our workhouses would be occupied with fewer cripples. If, moreover, it was recognized, as it should be, that many intra-capsular and all extra-capsular fractures unite when rightly treated, every case of fracture of the neck of the femur, impacted or non-impacted, intra- or extra-capsular, in the young, middle-aged, or old, would be treated as if repair and union were sure to take place if the parts are kept at rest and in apposition, and in the

FIG. 570.

Impacted Intra-Capsular Fracture of the Neck of Femur Repaired. (Case of the late Mr. T. E. Bryant. Prep. 1187[50], Guy's Mus.)

FIG. 571.

Doubly Impacted Fracture of the Neck of the Thigh-Bone.

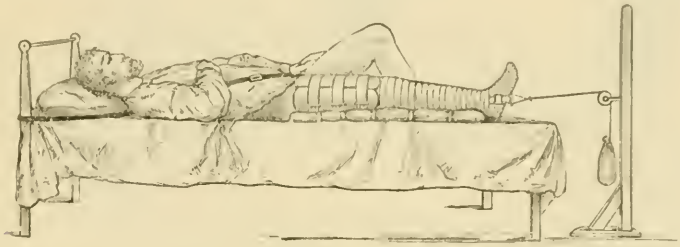
large proportion of cases the hopes of the surgeon will not be disappointed. (*Vide* statistics of my own cases, p. 887.) In the purely intra-capsular fracture union may take place, osseous in many cases (Fig. 570), fibrous in more (Figs. 565 and 574). In a few

there will be none, owing to a total separation of the head of the bone from its attachments or to the feeble power or age of the patient, or because the broken fragment receives too little nourishment to allow of sufficient reparative material being poured out, or because the fractured bones have not been kept sufficiently at rest and in apposition. Under these circumstances the head of the femur will be loose in the acetabulum, with its broken surface smoothed into a cup-shaped cavity, where the rounded end of the broken neck of the femur plays as in a false joint.

In the impacted fractures union ought to be looked for if the broken fragments are left alone and not loosened by a careless or too curious manipulation.

In the non-impacted extension is to be more thoroughly employed. The best splint for these purposes is my double one (Fig. 573). By it, in the non-impacted fracture, the

Fig. 572.



Gurdon Buck's Method of applying Extension in a Case of Fracture of the Neck of the Thigh-Bone.

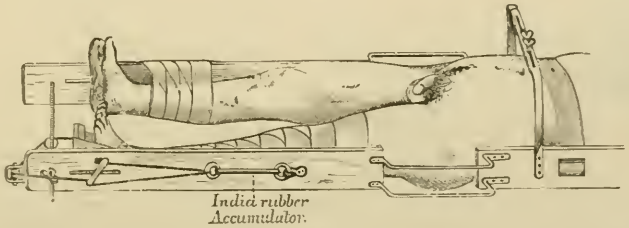
limb should be brought down to a level with its fellow and maintained there by means of the elastic extension pulley; by its means both limbs are kept parallel, no pressure is applied over the trochanters, abduction or adduction of the limb is prevented, and extension is maintained. With this splint no perineal band is required if the foot of the bed is raised two or three inches.

In the impacted fracture enough extension is required to neutralize muscular action, but no more.

Gurdon Buck's method of applying extension to the limb by means of weights has found great favor of late years in America and this country, and is doubtless very good and simple, the counter-extending force being applied by means of a perineal band of india-rubber tubing fastened to the head of the bedstead or splint, while the limb is steadied by means of long sand-bags applied laterally, or short thigh-splints (Fig. 572). This plan, however, has the disadvantage of not preserving sufficient immobility of the broken bones, and ought, therefore, to be employed only in conjunction with the long splint.

Sir A. Cooper's plan of placing the patient on a double inclined plane has few advantages when union is to be looked for, and even the broad well-padded belt which he

Fig. 573.



Double Splint for Fracture of the Shaft or Neck of the Thigh-Bone and Hip Disease.

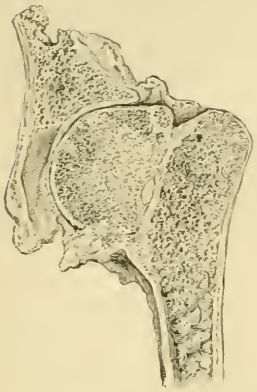
applied around the pelvis in order to keep the broken fragments closely together cannot be recommended; still where the long splint cannot be worn the inclined plane may be substituted.

When the necessary confinement to the supine position cannot be tolerated and bedsores appear, it may be necessary to give up the long splint, and under these circumstances it is wise to fix the hip, pelvis, and thigh in some strong, immovable casing similar to that employed in hip disease (Fig. 623), the limb being kept extended by

means of weights attached to the foot during the setting of the material. The casing may be of plaster of Paris, leather, felt, perforated zinc, or flannel, with starch or gum and chalk.

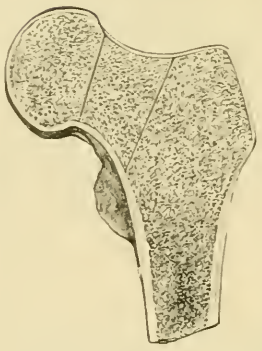
To allow the patient to get up without any apparatus is not only to give up all hope of a cure by union, but to add to the local irritation, as the broken fragments will grate against one another and irritate the soft parts around, often causing severe local and constitutional disturbance. Under all circumstances, however, immobility of the broken bone is to be ensured.

Fig. 574.



Fracture of the Neck of the Thigh-Bone within the Capsule; Repair of Fracture by Means of Bone, Fibrous Tissue, and Fibro-Cartilage; Absorption of the Neck of the Bone. (Prep. removed from woman æt. 60 who had received the injury five years before.)

Fig. 575.



Femur of the Opposite Side, showing the Amount of Bone Absorbed.

Interstitial absorption of the neck of the bone is sometimes met with after fracture, and in Fig. 574 the fact is well illustrated, the neck of the bone having almost entirely disappeared, as will be seen at once on comparing a section of the injured bone with that of the uninjured from the same subject (Fig. 275). It is said also to take place after a contusion without any fracture in osteo-arthritis; how far it may occur otherwise is an open question. My own impression is that in all such cases some fracture existed, though it is difficult to prove the truth of such an opinion. The question requires further elucidation.

Fractures through the trochanter occasionally occur—Sir A. Cooper describes them as oblique fractures not implicating the neck of the bone—and can be made out by the immobility of the lower portion of the bone whilst the upper part is fixed, and by the other signs of fracture, such as crepitus, etc. They should be treated like fractures of the neck.

Separation of the epiphysis of the head of the bone has been described. South has recorded such cases in his *Chelius's Surgery*, and Post of New York in the *New York Journal* (vol. iii.), but no preparation exists to demonstrate the fact. It is doubtless possible in the young, and would be known by some such symptoms as those of fracture of the neck, crepitus being exchanged for what South calls a "distinct dummy sensation" on rotating and extending the limb. As a consequence of disease it will be described in a later chapter.

Separation of the epiphysis of the trochanter major is a more definite accident, and doubtless has occurred. Sir A. Cooper recorded a case which Mr. Aston Key had observed, and the diagnosis was verified after death. In it, however, the detached fragment was not displaced, but held in position by means of its fibrous and tendinous coverings; the separation was the result of direct local violence; abduction of the limb caused great pain, but all other movements were allowed. The preparation exists in the Guy's Museum (1195) and is here figured (Fig. 576). A like case occurred in the practice of the late Mr. Poland, at Guy's, in 1871, which through his kindness I saw. It occurred in a boy æt. 12 from a direct blow, and was characterized by a projection and thickening of the trochanter (Fig. 577). Similar instances have also been published by Dr. Roddick of Montreal (*Canada Med. and Surg. Journal*, November, 1875). Mr. McCarthy (*Path. Trans.*, 1874), and Agnew in his *Surgery*.

Fig. 576.

Fig. 577.

Fracture of the Epiphysis of the Major Trochanter.

Mr. Aston Key's case. (Prep. 1195, Guy's Mus.)

Appearance during life. (Mr. Poland's case.)

Fracture of the Shaft of the Femur.—This may take place in any part, but is more common in the centre than elsewhere, and as a consequence of indirect vio-

lence; it may occur, however, as a result of direct force, and more rarely of muscular action. From this cause I have seen it from the swinging of the limb over the side of a cart in the act of descending, and in an epileptic patient from the spasm of the muscles with the patient in bed. I have known it also to take place from the same cause when cancer of the bone existed.

The fracture may be *transverse*, *oblique* in any direction, *vertical*, *dentated*, *comminuted*, or *impacted*, the nature of the force and its direction determining these points. A sharp blow is likely to be followed by a transverse fracture; a crushing force by a comminuted one; an indirect fracture probably will be oblique, according to the natural bend in the lower part of the limb. In the upper third the bone may be broken oblique from above and in front downward and outward, and from impaction of the lower extremity into the upper the latter fragment may be comminuted, the bone splitting secondarily upward

FIG. 578.

Impacted Fracture of the Shaft of the Femur produced by a Fall upon the Knee in a Man æt. 83.

into the neck. Dr. E. H. Bennett of the Dublin University has written an interesting paper on this form of fracture (*Brit. Med. Journ.*, June 26, 1880). In the middle of the bone a lateral obliquity is the most common; in the lower third an obliquity from behind forward. Fractures may also be double in the same bone, or compound. In the case illustrated (Fig. 578) the fracture was impacted, the upper fragment having been forced into the hollow of the lower, which it split. It occurred in a patient under my care in 1876, æt. 83, from a fall down an area upon his knee. The man died on the twenty-ninth day, from kidney disease (*Path. Soc. Trans.*, vol. xxix., 1878).

The displacement that takes place turns much upon the line of the obliquity and the position of the fracture. In fracture below the lesser trochanter the upper fragment is prone to be drawn forward by the action of the psoas and iliacus muscles and outward by the external rotators. In fractures above the condyles the lower fragment is apt to be drawn backward by the unantagonized action of the gastrocnemii muscles. In fractures of the centre of the shaft the deformity depends on the line of obliquity. Rotation outward of the lower fragment is found in nearly every case.

DIAGNOSIS.—There is usually no difficulty in diagnosing a fracture of the shaft, the following symptoms being usually present: A fall or injury, followed by loss of power in the limb; shortening, which extension can rectify; deformity, probably angular; extra mobility of the lower part of the injured limb; crepitus; and probably the projection of one end of a fragment with eversion of the foot. When the fracture is transverse, the shortening will rarely be marked; when it is oblique, the direction of the angular deformity often indicates the line of the obliquity.

In young children, where the fracture is incomplete, shortening with bowing of the limb after an accident, and an indistinct sensation of yielding on manipulation, with or without a peculiar crackling sensation, indicate the nature of the accident.

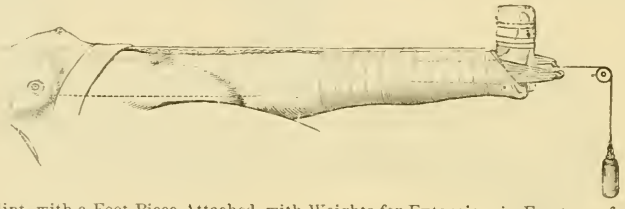
TREATMENT.—The fragments having been carefully adjusted by means of extension and gentle manipulation, the mechanical treatment of these fractures consists in the maintenance of extension by means of some applied force and the complete rest of the coaptated bones, gentle compression of the affected part sometimes being beneficial. To assist the surgeon toward these ends some anæsthetic may be used if the pain be severe and it is impossible by other means to keep the patient at rest and any spasmodic action of the muscles interferes with the surgeon's aims.

For many years past I have used no other splint than the double one seen in Figs. 573 and 620, and most surgeons who have employed it once adopt it. It does not shift from its place, because the interruption over the trochanter renders it comfortable; it keeps the fractured limb still and maintains it parallel with its fellow: extension can be carefully and easily regulated by means of the extension elastic pulleys, and no perineal band for counter-extension is needed; the results, moreover, which have attended its use are excellent. Thus, out of 100 cases consecutively treated in my wards with this splint, in

52 there was no shortening, in 36 there was half an inch or under, and in 12 only was there one inch. Four other cases died: 1, æt. 81, from senility; 1, æt. 83, on the twenty-ninth day, from kidney disease; 1, æt. 40, from abscess of the lung, on the twenty-third day; and 1, æt. 45, from delirium tremens, on the eighth day.

At other schools other means are adopted, according to the fancy of the surgeon and the fashion of the school. Thus, in hospitals where the Scotch influence is great Liston's long splint is the one usually employed, which should extend well up into the axilla and several inches below the foot (Fig. 579), without foot-piece. It ought to be well padded and supplied with a soft perineal band, such as a leather strap or a piece of india-rubber tubing. The ankle and instep should be well protected from pressure by cotton-wool and the retaining bandage applied with equal pressure.

Fig. 579.



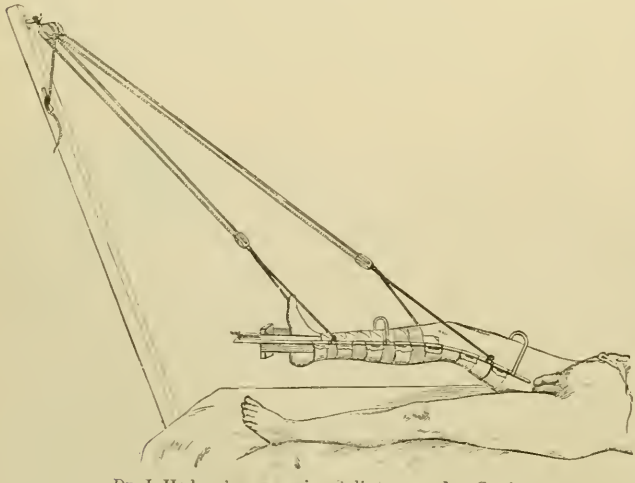
Liston's Long Splint, with a Foot-Piece Attached, with Weights for Extension, in Fracture of the Neck of the Thigh-Bone.

Where the long splint is employed, Desault's splint, with a foot-piece (Fig. 592), and the addition of a cross-bar for steadiness, should be preferred. The splint may be of wood or metal and made with a slide, so as to be adjusted to different patients. All long splints, however, without an interruption over the trochanter, as seen in Fig. 573, to guard against pressure, are inefficient and most uncomfortable.

In fractures of the upper third, where the upper fragment is apt to tilt forward and be rotated outward, the double inclined plane is often of great value. It should be employed, however, only when the long splint fails to fulfil the objects the surgeon has in view. It is daily dropping out of use.

A splint full of promise was introduced in 1875 into practice at Guy's Hospital (Fig. 580) from the Marine Hospital, Greenwich, and is still used by some of my colleagues. It is a modification of one invented by the late Dr. J. T. Hodgen of St. Louis, United States (*Treat. on Mil. Surg.*, by F. H. Hamilton, 1865, p. 411), for gunshot fractures, and is made of galvanized iron wire (No. 2). In it the injured limb may be supported on a piece of flannel, which is slung to the iron rod, or upon pieces of bandage. Extension is kept up by means of the strapping attaching the foot of the injured limb to the lower cross-bar of the splint, and through the suspending cords and pulleys. The counter-extension is maintained by the weight of the limb above the fracture and weight of the body. The splint, as seen in Fig. 580, is most comfortable to the patient, and an old house-surgeon, Mr. J. F. Fry, reports (*Guy's Gazette*, December 11, 1875) that out of seventeen cases of fracture of the thigh consecutively treated with the splint, the average amount of shortening was less than half an inch, and that in six cases there was not any. I have found, however, after a lengthened trial of this splint, that a much larger amount of callus is thrown out about the seat of fracture than is met with when the bones are kept perfectly at rest, as they are by the double splint

Fig. 580.



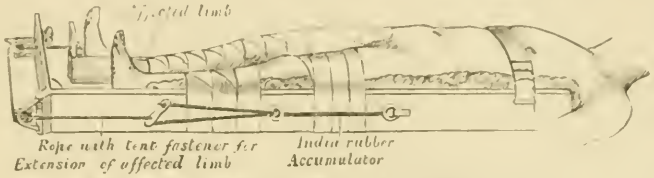
Dr. J. Hodgen's Suspension Splint, as used at Guy's.

(Fig. 573), and conclude from this fact that there is more mobility of the ends of the broken bone by the one form of treatment than by the other. Under such circumstances I have discarded Hodgen's splint in the treatment of fractures of the thigh for the double.

Hodgen's splint should not be confounded with Nathan Smith's, which is made of wire applied to the *anterior surface* of the fractured limb, which is suspended to it by rollers (Fig. 598).

When the fracture is compound, an interrupted splint may be employed. In addition to the long splint, short additional splints applied in front, or at the inner side of, or behind, the thigh, as the want of the individual case may suggest, are of great value to ensure greater steadiness of the broken bone. In no case should the seat of fracture be covered in. The bandage should stop below, and if necessary recommence above, it.

Fig. 581.



Mr. Campbell de Morgan's Splint, with Elastic Extension.

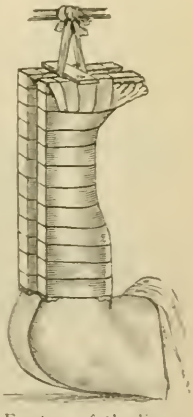
To prevent the bandage slipping after it has been applied, it is a good plan to give it one coating of paste or glue.

Many modifications of these means might be mentioned. Thus, Paget has very generally employed Busk's long splint, in which a joint exists opposite the hip, which enables the patient, after union has taken place, to sit up without affecting the thigh-bone. The late Mr. C. de Morgan of the Middlesex Hospital applied the extension to the fractured limb by means of a force carried from the foot through a pedal cross-bar to a long splint applied to the opposite limb (Fig. 581).

Sir W. Fergusson was wont to apply his counter-extension from a strong stay of jean, carefully fitted to the upper third of the opposite thigh, from which a band extended in front and behind to the upper end of the splint, thus doing away with the perineal pad.

During the application of the long splint steady traction should be maintained on the injured limb by a competent assistant. When muscular spasm is severe, some surgeons have advised temporary pressure on the femoral artery in the groin. It is said to stop the spasm in all cases; and whenever I have tried it, it answered well.

Fig. 582.



Fracture of the Femur in a Child treated by Vertical Extension.

Vertical Extension.—In infants and children under three years of age fractures of the thigh are treated with difficulty, for any immovable apparatus is constantly dirtied from urine, feces, etc., and requires to be changed, and the good that would otherwise be experienced is thus neutralized. On this account Paget and Callender have within the last few years treated many cases of fracture of the thigh in children without splints, all apparatus being dispensed with, "the child being laid on a firm bed, with the broken limb, after setting it, bent at the hip and knee, and laid on its outer side" (*St. Barth. Hosp. Rep.*, 1867). I do not recommend this practice, but would advise instead that the injured limb of the child, with the sound one, be flexed at a right angle with the pelvis, fixed by some light splint and hoisted upward to a cradle, hook, or bar above the bed (Fig. 582). By these means the weight of the body acts as a constant counter-extending force, the child can be well looked to for purposes of cleanliness, and a good result may be expected. Kümmell of Hamburg (*Berlin Klin. Woch.*, No. 4, 1882) holds this method of vertical extension in fractured thighs in infants to be the best. He says, though wrongly, it was first tried by Schede of Berlin in 1877, and publishes a list of twenty-eight cases so treated in infants under two years. In justice to Guy's, however, I must state that I began this form of practice at Guy's Hospital in 1870, and have before me a list of twenty-eight cases so treated since in children varying from eight months of age up to five years; later than that age I prefer the double splint.

Splints of gutta-percha, felt, or leather may be used with the weights when they can be applied, some immovable apparatus being adjusted after the second week; indeed, in some cases this immovable apparatus may be applied at once, care being taken that the limb is kept well extended during its application and setting. The Bavarian flannel splint is the best (Fig. 536).

In adults, also, after the fourth week, this same immovable apparatus may be employed with advantage, the patient gaining greater freedom. Some surgeons think so well of this plan as to advise its use in fracture of the thigh from the very first. Erichsen, its ablest advocate, says (*Science and Art of Surgery*, p. 225): "The starched bandage may be employed in most cases. The limb should be evenly and thickly enveloped in a layer of cotton wadding; a long piece of strong pasteboard about four inches wide, soaked in starch, must next be applied to the posterior part of the limb from the nates to the heel. If the patient be very muscular and the thigh large, this must be strengthened, especially at its upper part, by having slips of bandage pasted upon it; two narrower strips of pasteboard are now placed, one along each side of the limb, from the hip to the ankle, and another shorter piece on the fore part of the thigh. A double layer of starched bandage should now be applied over the whole with a strong and well-starched spica (Fig. 583); it should be cut up and trimmed on the second or third day and then reapplied." With such an apparatus Erichsen has treated many fractured thighs, in both adults and children, without confinement to bed for more than three or four days, and without the slightest shortening or deformity being left. The points to be especially attended to are that the back splint be very strong, at the upper part especially, and that the spica be well and firmly applied, so that the hip and the whole of the pelvis be immovably fixed.

Fig. 583.

From Erichsen.

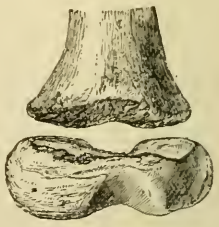
Fractures of the condyles necessarily involve the joint, and these may be transverse, oblique, or vertical (Fig. 584). In subjects under twenty-one *the lower epiphysis may be separated from the shaft*, thus simulating a transverse fracture (Fig. 585) or a dislocation (Fig. 521).

These cases are serious on account of the joint complication, as some stiffness of the joint generally, but not always, follows this result, depending upon the amount of inflammatory action that takes place after the injury. When the head of the tibia is fractured into the joint, the same observations are applicable. In these cases the posterior splint, as suggested by MacIntyre (Fig. 597), is probably the best, the knee being slightly flexed. When joint complication exists, the application of ice, or probably some leeches, may be required.

Fig. 584.

Fracture of the Shaft of the Femur, with Longitudinal Fissure through the Condyles into the Knee-Joint. (Prep. 1200, Guy's Mus.)

Fig. 585.



Separation of the Epiphysis. (Prep. 1210[5], Guy's Mus.)

In exceptional instances the upper fragment of bone is driven into the lower, thereby giving rise to an impacted fracture. These cases, like other impacted fractures, generally do well by simple rest.

In all cases involving joints passive motion should be allowed at the end of five or six weeks.

Nathan Smith of New York advocates the use of an anterior splint composed of a single piece of iron wire of the thickness of a No. 11 catheter, which is carefully bent to the inequalities of the limb and fastened to it by means of strapping and bandages, the limb being subsequently suspended to the ceiling by a cord connected with the wire above and below the knee, extension being made through this cord, and the counter-extension by so raising the foot of the bed as to tilt the body toward its head (Fig. 598).

In fractures of the lower third above the condyles, where the gastrocnemii muscles tend to draw the lower fragment backward into the popliteal space, some

surgeons prefer the use of the inclined plane, and where the bones cannot be otherwise kept in apposition it is probably a sound practice. But what I believe to be a better one is the division of the tendo Achillis and the subsequent use of the long double splint. The division of the tendon paralyzes the gastrocnemii, and thus allows the surgeon to bring the bones into a good position and to deal with them as with an ordinary fracture. I have taught this for many years, and, having tested its value in three cases, can pronounce the practice to be good. My friend Mr. Treves of the London Hospital followed the practice in 1882 (*Brit. Med. Journ.*, February 17, 1883), and it has likewise been practised by Dr. Morris of Boston, in America, with success (*Boston Med. and Surg. Journ.*, November 29, 1877).

Compound Fractures of the Thigh.—These are desperate accidents, and take place in the proportion of one to every six or seven cases of fracture of the femur; and when they occur, half the patients die. They should be treated, where possible, on conservative principles, and amputation should be performed only when the soft parts, with the vessels and nerves, are so injured as to forbid any reasonable hope of recovery. Conservative practice should have full scope, in young subjects especially, and when any doubt upon the necessity of amputation exists, the surgeon had better decide upon trying to save the limb, although in the aged an opposite practice should be adopted.

Army surgeons, however, advise the propriety of practising conservatism for gunshot fractures in the upper third of the thigh and amputation for all fractures of the middle and lower thirds, the nature of gunshot injuries to those parts precluding all hope of a natural recovery. All modern army surgeons—English, American, French, and German—agree upon this point, and endorse Dupuytren's, Hennen's, Larrey's, and Guthrie's opinion that, in gunshot wounds of the thigh, "in rejecting amputation we lose more lives than we save limbs," and "that in the exceptional cases which result in consolidation the condition of the limb is not encouraging."

Amputation of the thigh for compound fracture is most fatal, two out of three dying. In the upper third of the thigh the mortality is still greater.

It is from this fact alone that army surgeons have advised the conservative treatment of compound fractures of the upper part of the femur, and Mr. Erichsen has been led to assert that amputation in the upper third of the thigh for compound fracture is an unjustifiable operation.

When amputation is not at once called for, the wound should be thoroughly cleansed with some iodine or other antiseptic lotion, and all foreign bodies, with loose fragments of bone, removed; the projecting portions of bone should be excised, bleeding arrested, and the wound sealed with blood or the compound tincture of benzoin: a splint should be applied at once, moderate extension employed, and the case treated on general principles.

Fractures of the Patella.—These are usually transverse, from a sudden action of the quadriceps femoris under a violent effort to prevent the body falling backward, the knee being at the time partially bent. Such fractures are met with chiefly near, though mostly below, the centre of the bone; they may, however, occur at any part, even in the extra-articular portion of bone. In some cases both patellæ are broken, together or consecutively; in rarer instances the same patella may be broken more than once. I have had such a case in a man in whom one patella had been broken twice and the other three times, and in the Guy's Museum there is a preparation (Fig. 586) from my father's museum in which the bone had been broken transversely into four fragments, probably from different injuries or from some direct force, each fragment having a ligamentous union.

Fig. 586.

Multiple Fracture of Patella. (Prep. 1212[3].)

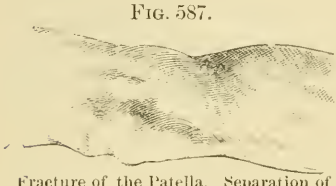
These transverse fractures are at times, although rarely, the result of direct violence. The French and American surgeons believe them to be so very frequently. Direct violence to the patella, however, is more commonly followed by what is called a starred or vertical than by a transverse fracture, and in these cases there is rarely much separation of the fragments. In transverse fracture the separation is sometimes very great, this fact mainly depending upon the amount of muscular action at the time of fracture. It is, however, greatly increased by the effusion of blood that follows the injury, and later on of inflammatory exudation. At a still later period it is increased from a yielding of the ligamentous tissue by flexing the leg before firm union has taken place.

Out of 25 consecutive cases which passed under my care, in 7, on convalescence, the

union was so close as to have been reported as bony; in 9 there was separation of only a quarter of an inch; in 8, of half an inch; in 1, of one inch. In all of these the movements of the joint were perfect.

Diagnosis.—The diagnosis of the transverse fracture is rarely difficult, the nature of the violence, the sudden loss of power of the limb, the distinct separation of the fragments, and the bulging of the synovial sac between the divided portions of bone being characterteristic. In the *starred* fracture the different pieces of bone may be made out. In the *vertical* the diagnosis may be more difficult, and can be made out only by manipulation. In exceptional cases where either the ligamentum patellæ or the tendon of the extensors above the patella is broken some difficulty may be felt, but such accidents are very rare. When the transverse fracture is little more than a fissure, no separation will be found, the amount of separation being determined by the extent of laceration of the fibrous and tendinous coverings of the bone. When the laceration is partial and the separation slight, there is a better hope of a bony or close union than when the laceration is complete and the separation great. It should be known, however, that union by bone may take place, although probably but seldom; that union by strong ligament, with about half an inch of separation, is more common; and that non-union is exceptional. William Adams in the *Path. Trans.* (vol. xiii.) informs us that out of 31 specimens he examined, 15 were examples of ununited fracture, 12 of true ligamentous union, and 4 doubtful. In the ununited the separation was very great; in the ligamentous it was rarely beyond an inch and a half. In the ununited the separated fragments were connected with each other by only a single layer of fibrous tissue.

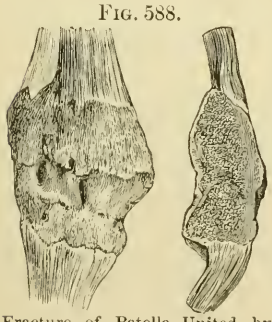
Fig. 587.



Fracture of the Patella. Separation of Fragments.

That bone union now takes place is generally recognized. In Prep. 1211[57], Guy's Museum (Fig. 588), taken from my father's museum, the fact is well exemplified. The specimen has been fully described, with remarks, by the late Mr. W. King in the *Guy's Hosp. Rep.* (Series i. vol. vi.)

Fig. 588.



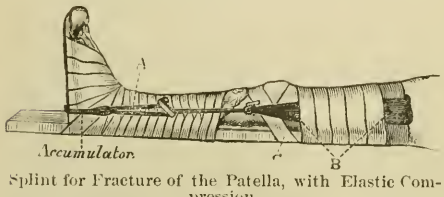
Fracture of Patella United by Bone.
Anterior surface. Vertical section.

In the starred or vertical fractures osseous union is generally secured, these cases being rarely attended with complete laceration of the periosteal or fibrous coverings of the bone.

Treatment.—In all cases, as well as in every form, of fractured patella, a long well-padded posterior splint with a foot-piece extending from the tuberosity of the ischium to the foot should at once be adjusted, the knee-joint being left uncovered by the bandage. To the knee-joint cold should be applied, for as a direct consequence of the accident blood is very apt to be effused, and as a secondary effect synovial inflammation with effusion is almost sure to ensue. Should the joint be hyper-distended with blood, such may be removed by the aspirator.

It has generally been the custom to raise the heel with a view to destroy the action of the extensor muscles, but it is now more generally believed that no good is derived from such a measure; as a consequence, the horizontal position of the limb is usually employed, the body being raised. The fragments should be brought together at the same time as much as possible by the fingers of the surgeon, and later on by some apparatus. To do so, however, while blood exists to any extent or the synovial capsule is distended with inflammatory effusion is not wise, since any attempt to draw the bones together under these circumstances can result only in tilting forward the surfaces that are required to be brought into apposition, with no good effect.

Fig. 589.



Splint for Fracture of the Patella, with Elastic Compression.
A, Cord with tent-fastener to regulate extension.
B, Band or strapping bound to Thigh.

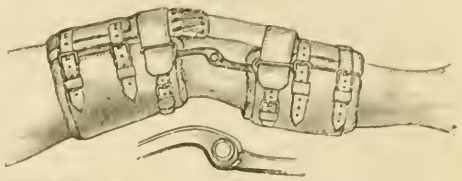
For a few days, therefore, until all inflammatory action has subsided, the surgeon should rest satisfied by simply pressing the parts together with his fingers; and when this result has been secured, the two portions may be drawn together by means of strips of plaster diagonally applied, of india-rubber bands covered with wash-leather attached to

hooks, which have been inserted at intervals of an inch on either side of the splint, or, what is better, by means of elastic compression as shown in Fig. 589.

Malgaigne's hooks, which are composed of four claws drawn together by a screw, have been much employed, and are doubtless effectual, but from the fact that they penetrate the soft parts and painfully and forcibly draw the broken fragments together they are objectionable. Good results have, however, been reported from their use.

As soon as all inflammatory action of the joint has subsided and the bones are fairly in position such an immovable apparatus as the flannel Bavarian splint may be applied, the patella being left exposed or not as the surgeon may think fit. When the bone is bandaged over, care must be taken not to press upon it, as I have known secondary suppuration with necrosis and joint complication of a serious nature thus ensue. Erichsen uses, as a rule, the starch bandage, and speaks highly of it. He applies it over a pad fixed above the fractured bone with a figure-of-8 bandage. C. Heath removes fluid by aspiration, applies a plaster-of-Paris bandage over cotton-wool, and allows his patient to get up.

Fig. 590.



The Middlesex Hospital Splint for Fracture of the Patella.

Whatever apparatus is employed, it should be kept on for five or six weeks at least; and when removed, some light leather or felt casing should be substituted. It is hazardous to allow the patient to flex the limb under three months and to give it freedom under a year; for the united ligament is apt to be stretched and elongated, and the limb weakened. An apparatus to limit the movement of the joint should be worn after this accident. One made by Hawksley and long used at the Middlesex hospital is excellent (Fig. 590). "It is applied as soon as the patient is allowed to get up, and the degree of flexion is gradually increased from time to time by filing away the shoulder of the joint of the splint."

Within recent times surgeons have advocated the primary treatment of these fractures by wiring the fractured bones together, and successes have been obtained—some excellent, others indifferent, few better than the average obtained by the treatment above described. Sir J. Lister has been amongst the most successful. So far as I can make out, the first case recorded is by Dr. Uhde of Brunswick (*Deutsche Medicin und Wochens.*, April 27, 1878). I cannot recommend this practice to be universally adopted. It is eminently hazardous; and when we know that in the majority of cases of fractured patella treated without operation results are obtained which in exceptional cases alone interfere with life's duties, the treatment by operation stands condemned as a rule of practice.

In 32 cases of old fracture of the bone which have been admitted into Guy's for other injuries, in 28 the limb was in all ways useful; in 4 only was it weak, and in these 4 the separation between the fragments was half an inch in 2, one inch in 1, and two inches in the fourth; whereas, in the patients with useful limbs, one man could go up a ladder with two hundredweight on his shoulder, another acted as porter in a fish-market, a third was a lighterman, two were coal porters, a sixth was a sailor, a seventh a carman, an eighth a marine engineer. In one man with a perfectly useful limb the fragments were three inches apart; in another, who could walk well, both bones were fractured and the fragments two inches apart. In a cellarman who had good use of his leg the separation was four inches. In the majority of the good limbs the separation was about half an inch. Upon the whole, the result of the accident was most satisfactory and enough to justify the ordinary modes of treatment employed.

In examples of neglected cases of fracture where a great separation of the fragments exists, and the knee is consequently so weak as to be useless, such an operation as has been described may be justifiable, but under other circumstances I cannot, as a teacher, regard it otherwise than as a rash and hazardous proceeding.

Compound Fractures of the Patella.—These are grave accidents, one-fourth of the cases dying. Poland in an able paper read before the Royal Med. and Chir. Society (1870) gave an analysis of 85 such, and clearly proved that in all cases we should attempt to save the limb and adopt the ordinary treatment as for simple fractures of the patella. To this end the wound should be well washed with iodine water or carbolic acid lotion and accurately closed by sutures, and inflammation ought to be subdued by the constant application of cold. If suppuration sets in, free incisions should be made into

the joint, and amputation resorted to only when the powers of the patient fail to repair the injured joint. Detached fragments of bone should, however, be removed at once.

Out of the 85 cases collected by Poland, there were 20 deaths and 65 recoveries; in 31 of these there was more or less complete anchylosis of the joint; 20 recovered with movement, 4 were resected, and 5 amputated. The joint suppurated in 43 out of the 65 cases of recovery, and in all the fatal cases.

Fig. 591.

Arrest of Growth in Shaft of Right Tibia (1 inch), with Bowing of Fibula, following Injury to Upper Epiphysis two years before, in Child æt. 8.

In March, 1883, I saw a man æt. 56 who after a compound comminuted fracture of the patella had necrosis of about a quarter of the bone. He made a good recovery after the removal of the dead bone, and had almost complete movement of the joint. The case occurred in the practice of Mr. Wilson of Grantham.

Fractures of the Leg.—These are about twice as frequent as those of the thigh. At Guy's, 1090 cases were admitted in six years, against 541 of the thigh; and of these 202, or one-fifth, were compound. Of the simple cases not one per cent. died from all causes, and of the compound twenty-seven per cent. succumbed.

Both bones, as a rule, are fractured, the fibula alone being broken in about one case in six, and the tibia in about one in seven. Lonsdale's statistics indicate these points. These fractures are more commonly met with in adult than in child life.

In fractures of both bones those of the upper half are usually the result of direct violence—fractures of the lower half of indirect, such as the twisting of the foot or leg from a fall or a jump.

In fractures of the tibia alone the line of fracture is frequently transverse, and from this cause there is sometimes difficulty in making the diagnosis, the nearer the fracture to the knee, the more transverse being the line. These fractures arise chiefly from direct violence. They may so unite as to leave no external trace of injury; indeed, they may be attended with so little displacement that the line of the bone is never broken. I have seen more than one patient walk upon the fractured limb directly after the accident, and in one case the man went up a whole flight of stairs to his ward with but a slight limp. In another, under my care in 1874, a woman with a fractured tibia and fibula went about for a week. In a medico-legal point of view these facts are important. When the shaft has been separated at its upper epiphysis, some arrest of growth may take place; and such a result is illustrated in Fig. 591.

Fracture of the fibula is more common than that of the tibia, particularly in its lower third; and I believe that in many examples of what are called bad sprains a fracture exists. Fracture in the upper two-thirds is usually caused by direct violence, but it may be by indirect, such as a wrench or twist of the ankle-joint; under such conditions the fracture will be oblique; in the lower third the violence is commonly indirect, such as a lateral twist or a forcible eversion of the foot. With pedal *in*version, the extremity of the tibia is mostly broken off. When with this fracture the foot is displaced *outward* and its outer edge raised, the accident is known as "Pott's fracture" (Fig. 522), and under these circumstances the external ligament remains entire, the force being concentrated against the fibula from two to three inches above the malleolus; the internal ligament, however, is ruptured or the inner malleolus is fractured. Displacement of the foot is not necessarily an attendant upon the fracture. It seems to be the result of some continuation of the primary fracturing force or of some additional force, such as that of an attempt to walk. In the indirect fracture the line of fracture is probably oblique, the obliquity being determined by the direction of the force.

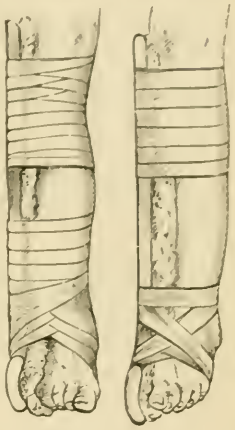
Diagnosis.—In fracture of either of the leg-bones alone the diagnosis may be somewhat difficult, and more particularly when no displacement is present. Crepitus may at times be made out by a forcible attempt to move or bend the lower fragments, or by some sudden inversion or eversion of the foot; but in trying for this the surgeon should be careful not to do harm. Local pain, however, caused by pressure with the thumb over the seat of fracture, and linear ecchymosis a few days after the accident, are valuable helps to diagnosis in these as in all other kinds of fracture.

Protracted or repeated examinations of the injured limb should always be avoided; they only add to the mischief.

Treatment.—In fractures of either of these bones a natural splint is always found

in the same bone; consequently, shortening or deformity rarely follows the accident. What the surgeon has to do is simply to apply some splint to ensure rest to the broken bone and to the muscles that move the foot—to the inside of the leg when the fibula is broken (Fig. 593), and to the outside when the tibia (Fig. 592); the splints should have a foot-piece. In fractures of the lower third of the fibula the foot may be drawn inward, the bandage being applied from without inward, but in many instances nothing more is called for than absolute rest. In other cases a thick pad is often of use opposite the seat of fracture. In no case should the bandage cover the fracture. After the lapse of a few days, or at most a week, when all swelling, with other evidence of local injury, has subsided, the limb may with advantage be put up in some immovable apparatus.

Fig. 592. Fig. 593.



In cases of Pott's fracture, or dislocation of the foot outward with fractured fibula, Pott used to place the patient on the affected side with the injured limb flexed, fixing the leg upon an outside splint, an inner splint being likewise very usually applied. A better plan, however, is found in the posterior and two lateral splints, with a swing, as seen in Fig. 596, this mode of swinging the limb being a very good substitute for Salter's swing (Fig. 597).

Fractures of both bones occur in every variety, and the most common is the transverse, about three inches above the ankle; but every form of oblique, dentated, comminuted, and vertical fracture is met with (Fig. 532). When near the joints, the vertical into the joint is by no means rare. The surgeon in his first examination of the fractured limb should, if possible, make out the line of obliquity of the fracture and the *tendency* one or other of the fragments may have to ride in any one direction, always observing the utmost gentleness in his manipulation.

When the tibia is broken at the junction of its middle and lower thirds, and the extremity of its upper fragment on its inner or subcutaneous surface presents a V-shape (Fig. 594), the surgeon may expect to find a fissure in the lower fragment of bone starting from the apex of the V and running in a spiral direction inward, backward, and outward round the inner edge of bone, across its posterior surface toward the lower articular facet where the tibia and fibula articulate, the fissure then passing horizontally inward across the lower articular facet of the tibia to the posterior border of the inner malleolous to join the one on the posterior aspect of the bone, thereby cutting off a triangular fragment of the tibia at its lower extremity.

Fig. 594.

V-shaped Fracture of Tibia, with Spiral Fissures. (Figure taken from a preparation of Gosselin, now in Dupuytren's museum.)

This variety of fracture is generally produced by some sudden twist of the body when the foot is fixed.

It may be suspected during life when joint complications are associated with the fracture. It was first described by M. Gosselin (*Gazette des Hôpitaux*, 1855).

When compound, it is generally of a serious nature, and, according to Gosselin, should be treated by amputation. Dr. R. M. Hodges of America goes so far as to say that by such a practice alone can the patient's life be saved (*Boston Med. and Surg. Journal*, January, 1877). Death usually takes place from pyæmia in cases that are left alone.

I am not disposed, however, to go so far in this direction, though I fully recognize the serious nature of these cases and believe that they claim the surgeon's anxious attention.

In transverse fractures there is rarely deformity. In the oblique it is a common result, the upper extremity of the lower portion of bone projecting, as a rule, the lower fragment being rotated outward from the great tendency the foot has toward eversion.

Symptoms.—The symptoms of fracture of the leg are too plain to be overlooked. The tibia being a superficial bone, any solution of continuity or deviation of the line of its spine is readily made out, the nature of the accident, loss of power, deformity, and crepitus helping the diagnosis. In fractures near the joint it may at times be difficult to make out whether the bone is fractured into the joint or not; and when a doubt exists, caution in prognosis and treatment should be observed. In fractures close to the ankle accompanied with displacement dislocation may be roughly simulated, but the

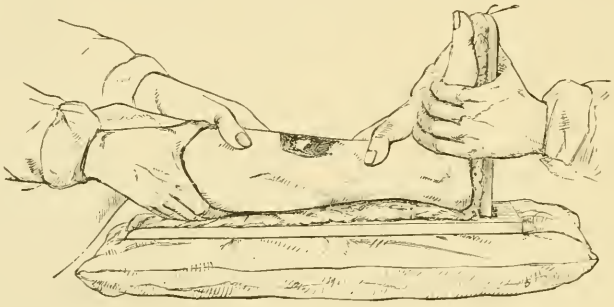
slightest care ought to detect the true nature of the case; the facility with which the displacement of the parts is rectified, the fact that the malleoli retain their normal relative position with the foot, and that the ankle-joint moves with facility, proves that the displacement is due to broken bones, and not to dislocation of the joint. When the lower epiphysis of the tibia is displaced with the foot, there may be some difficulty in making out the true state of the case, but such an accident can occur only in children; it will appear as a transverse fracture, but with no sharp edge of bone, as is usual in fracture, while replacement of the displaced fragments will not give rise to the ordinary crepitus of broken bone, but to a more subdued sensation.

When a wound complicates the case, the diagnosis is readily made.

Treatment.—It is wise, in fracture of the leg as of other bones, to "set" the fracture and to put the injured limb into the right position with good splints *as soon as possible*.

In a general way, for fractures of the lower two-thirds of the bones the best apparatus is a straight, flat, and not too broad, metal or wooden posterior splint (Fig. 595) with a

Fig. 595.

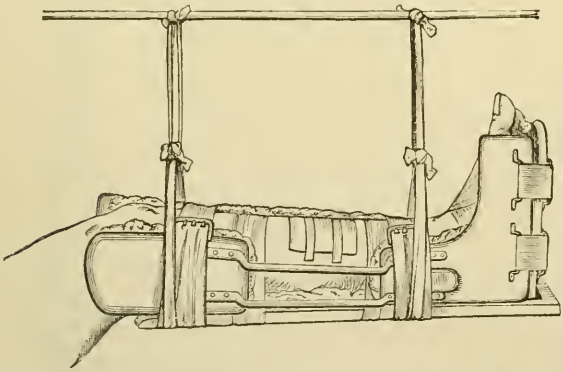


Process of Setting a Fracture of the Leg.

rectangular foot-piece and two broad lateral splints (Fig. 596), all being well padded and firmly fixed by broad strips of strapping, broad bands of inelastic webbing or bandages, the seat of fracture being left exposed, if possible, for observation. In Fig. 596 the whole apparatus is illustrated with an interrupted splint as for compound fracture. In reducing a fracture of the leg the knee should be partially flexed or held by an assistant, the surgeon manipulating the lower portion (Fig. 595).

During the putting up of the fracture the limb must be kept extended and the broken bones maintained in position, it being a good plan to fix the foot and limb at first to the posterior splint, and subsequently to apply the lateral. The leg afterward should be slung to a cradle by bandages (Fig. 575), or Salter's cradle may be used (Fig. 597). When any wound in the soft parts exists, as in compound fracture, the corresponding lateral splint should be interrupted, as shown in Fig. 596.

Fig. 596.



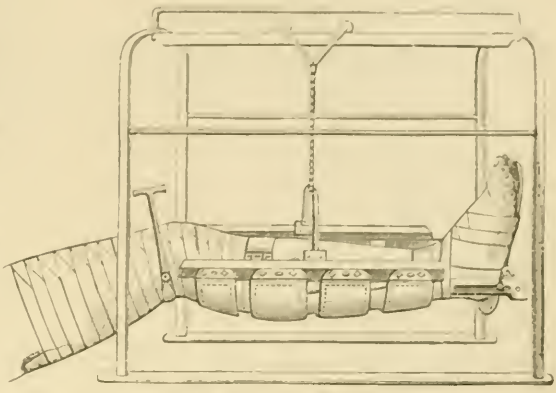
Apparatus for Fixing and Swinging a Fracture of the Leg.

When the fracture is close to the ankle-joint and any difficulty is experienced in keeping the broken bones in position from the spasmodic action of the tendo Achillis, the tendon should be divided. This simple operation at once permits the parts to be adjusted with admirable facility and renders the retentive apparatus of real value, while it allows natural processes of repair to go on uninterruptedly, the divided tendon and broken bones undergoing repair together.

When the fracture is near or into the knee, a posterior splint such as that of MacIntyre or Amesbury may be employed; indeed, some employ this splint for most fractures of the leg (Fig. 597).

In setting any fracture of the leg the opposite limb should be exposed as a guide and an inquiry made to prevent error as to the existence of any natural or acquired deformity. The foot should generally be placed at right angles with the leg, with the sole flat to the foot-piece, care being observed that the heel does not fall and the lower fragment of bone consequently tilt upward. The heel should also be well protected from pressure and the foot covered and protected with cotton-wool. "Take, therefore," writes Paget (*Lancet*, February 27, 1869), "the foot-piece of the splint as the guide for the position of the foot; and if you but see, in the management of fractures of the leg, that the foot of the patient and the foot-piece of the back splint fairly correspond, it is hardly possible for the limb to fall into any defective method of repair. Correspondence between the axis of the foot and of the foot-piece ensures that there shall be no rotation or version, either outward or inward. Then, again, you should be careful that the foot touches the foot-piece by the three balls of the sole—the ball of the heel, the ball of the great toe, and the ball of the little toe."

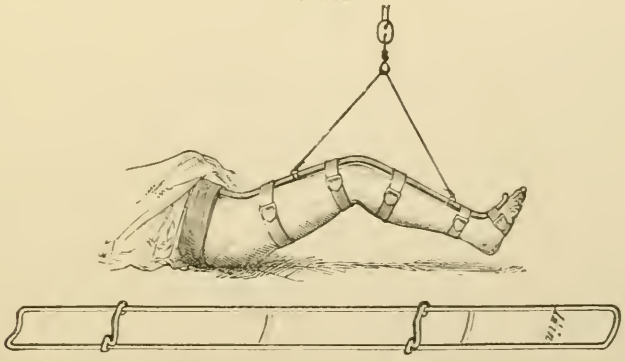
FIG. 597.



MacIntyre's Splint and Salter's Swing.

Dr. Shrimpton of Paris, acting upon Dr. Nathan Smith's suggestion of an anterior wire splint, has applied it to fractures of the leg with success. He employs a splint composed of double wires an inch and a half apart, held together by four transverse bars and applied by means of straps to the front of the leg, as illustrated in Fig. 598 (*Lancet*, 1872), the

FIG. 598



Nathan Smith's Anterior Wire Suspension Splint, with Dr. Shrimpton's Modification of it below.

limb being subsequently slung in a vertical direction, as Esmarch slings his patient's leg in disease of or after operations upon the ankle. After the limb has been kept in splints for about a month some immovable apparatus, such as the flannel Bavarian (Fig. 536), may be substituted and the patient allowed to get up, moving about with crutches for another month. When there is little or no displacement and little swelling, as soon as the immediate effects of the injury have passed away the immovable splint may be at once applied—that is, after the first week—the wants of the individual case being the only guide to its treatment. When the bones are comminuted and some loose portion has a tendency to ride or rise out of its position, the application of a pad, with sufficient local pressure to keep the parts in position, may be employed. When much effusion of blood or local action takes place, ice or cold lotion may be used as an application. Constitutional symptoms can be treated as they arise.

Compound fractures of the leg ought to be adjusted in the same way as the simple, care being taken to have an interruption in the splint corresponding to the wound (Fig. 596). When the wounds are extensive, the posterior hollow splint of MacIntyre or any of its modifications may be used with advantage.

When the bones are comminuted, the loose pieces should be removed, the wound

cleaned and sealed with a pad saturated with blood, the compound tincture of benzoin, or carbolic acid, as already described; at a later period of the case, when inflammation and suppuration take place about the seat of fracture, a free incision should be made down to the bone and any necrosed fragment removed. This operation gives relief to pain and expedites recovery.

When the injury to the soft parts is great and the large vessels or the joint are involved, amputation may be called for.

About one in every three cases of fracture of the leg is compound, the average mortality of the compound being also about one in three. Of those amputated, about sixty per cent. are fatal.

When amputation is called for, a primary operation—*i. e.*, one performed during the first three days—is better than a later one.

Fractures of the foot, commonly the result of some crushing force, are always serious on account of the injury the soft parts have sustained in common with the bones. When not so complicated, severe fractures of the bones of the foot as well as other bones will recover by rest and the application of cold lotions, etc.

Fracture of the **os calcis** may occur by a fall from a height. It is seldom associated with any displacement and undergoes excellent repair when natural processes are left to themselves. In exceptional cases the broken fragment may be drawn up by the action of the gastrocnemii muscles, and under such circumstances the leg must be kept flexed and the foot extended to keep the fragments in position by some outside splint. Under these circumstances, however, the foot rarely recovers completely its natural use.

Fractures of the **astragalus** also occur from some fall or violence, and are often compound. I had a case some years ago in which the upper surface of the bone with its head was split off and forced through the skin, and a second in which the bone was crushed into fragments and extruded from below the external malleolus. In the former the soft parts were so injured that amputation was performed, while in the latter recovery took place by natural processes with a stiff but good limb.

Simple fracture may, however, occur, and I am disposed to think it is more common than is supposed; but the injury is difficult to diagnose, particularly when no displacement coexists. I have had occasion in two cases to remove from boys who had acute inflammation of the bone and joint, following an injury, the whole of the necrosed upper articular surface, with half the thickness of the astragalus, and in both good results followed. The piece I removed in both instances looked as if it had been fractured, and subsequently died. I have also recently (1878) removed from the inner aspect of the ankle of a man the upper half of the astragalus that had been fractured six months previously, rotated, and so displaced as to present its upper articular facet inward. The case had been reported at a sister-hospital as one of fracture of the tibia and fibula. The fractured bone had subsequently inflamed and died.

Compound fracture of the **metatarsal** and **phalangeal** bones should be treated on ordinary principles, the immediate dressing of the wounds with the compound tincture of benzoin, to exclude all air and place the wound as much as possible under the condition of a subcutaneous one, being absolutely indicated. When parts irreparably injured require to be taken away, no healthy structures ought to be sacrificed in order to perform a named operation.

COMPLICATED FRACTURES.

Extravasation of Blood.

Fractures are very often complicated with *extravasation of blood*, and then difficulties may be experienced in deciding whether the blood comes from an artery or from a vein. In compound fracture, however, the difficulty of diagnosis is less than in the simple, since the florid character of the flowing blood, its pulsatile stream, and its capability of being arrested by pressure on its cardiac side indicate its arterial source. In simple fractures the difficulty is sometimes very great, particularly when the limb is distended with blood and there is no pulsation in the swelling. When the vessels below the seat of injury pulsate naturally, the blood has probably a venous origin; but when pulsation is not felt, there is no reason to jump to the conclusion that arterial laceration has taken place, as the arteries may be simply pressed upon by the effused blood. When the swelling itself pulsates, the diagnosis is simplified; for such pulsation generally means that a traumatic aneurism has formed and some large artery been ruptured. In a clinical point of view,

however, the question, happily, is not very material, as surgeons are now tolerably well agreed as to the practice to be pursued.

Treatment.—In **compound fractures** the injured vessels should be tied or twisted, and the wound should be enlarged for this purpose when necessary; and even where such a practice is impossible, and from the nature of the fracture and condition of the soft parts it is probable that the limb may be saved, the main artery should be tied higher up, as fractures heal well with a diminished supply of blood. Years ago, when a student, I remember a case of Mr. Brausby Cooper in which a compound fracture of the leg was complicated with a laceration of the femoral artery, and the artery was secured at the seat of injury. Repair went on in the fracture as well as in any case I ever witnessed. Mr. Brausby Cooper has also recorded in his *Surgical Essays* a case of fracture of the femur where the femoral artery was ligatured for a ruptured popliteal artery, and recovery took place in six weeks.

In the autumn of 1873 a youth æt. 18 came under my care with a compound fracture of the condyles of the humerus into the elbow-joint, and an injury to the brachial artery about its centre sufficient to arrest all circulation through it. The wound into the joint was extensive, but, as my dresser had sealed it well with lint soaked in the compound tincture of benzoin before I saw it, I thought it wise to leave the case to nature. The youth went on well without one bad symptom, and left the hospital with a movable joint. I am disposed to attribute the well-doing of this case to the fact that the brachial artery was obstructed.

When, however, the condition of the limb at the seat of fracture is such as to forbid any hope of its recovery being entertained, primary amputation ought to be performed; if a doubt exists as to the probability of the limb being saved, the artery should be secured in or above the wound, and amputation should be performed as a secondary operation if the attempt fail to save the limb, the chances of a successful result in primary and secondary amputation being about equal.

In **simple fracture,** when there is great effusion of blood and no pulsation in the swelling or vessels, the expectant treatment is the right one to adopt, the injured limb being kept at rest and elevated and cold applied. When pulsation in the swelling is felt and it is clear that arterial laceration has taken place, the same practice ought also primarily to be adopted, since every hospital surgeon knows that these cases often do well under such treatment. I can recall several where it was as clear as symptoms could define that with fracture of the bones of the leg severe arterial laceration existed, and yet a good recovery ensued. To cut down at the seat of injury and secure the wounded artery is what no one at the present day advocates, although John Bell laid it down as a law that such a rule should be followed: but to do so above the seat of injury is one that commends itself to the surgeon's attention when it is clear that some treatment is requisite for the wounded vessel, and that the fracture and parts around are progressing toward recovery. When gangrene of the limb threatens, it would be as unscientific as it is useless to adopt this practice, amputation, under such circumstances, being alone applicable.

Summary.—By way of summary, it would appear that in **compound fracture** complicated with arterial hemorrhage the vessel ought to be secured—if possible, in the wound, if not, above it—and that primary or secondary amputation should be resorted to only when the local injury forbids any hope of a natural recovery being entertained.

In **simple fracture** the expectant treatment should, as a rule, be adopted. If, from the progressive character of the hemorrhage, interference is absolutely demanded, the artery should be secured above the fracture, and amputation had recourse to when gangrene of the limb follows. Pressure upon the afferent artery is a practice that also demands attention.

In exceptional cases it may be expedient to cut down upon the wounded vessel at the seat of injury.

Fractures implicating Joints.

These are generally grave injuries, though in *simple* fractures the worst effect that is usually to be looked for is some stiffness or anchylosis of the articulation. Yet this result is not constant, and a movable joint is not rarely secured. As a matter of precaution, however, the surgeon should warn the patient of the risk and be careful always to adjust the fracture and limb in the most useful position for a stiff joint. Such cases require very careful treatment, absolute immobility of the injured bone and articulation being essential points to be observed; the joint, if inflamed, must be treated upon ordi-

nary principles. Passive movement of the joint should be commenced after the lapse of four or five weeks.

Compound fractures into joints are among the most serious cases the surgeon has to treat, and in the lower extremity generally require amputation. In the knee-joint this practice is the best when the wound is great and the fracture severe, though exceptional cases are on record in which excision has been employed. In less severe examples an attempt to save the member may be made, secondary amputation being performed when ill-success follows. The same rules are applicable in these cases as in wounds of joints, a simple fissure of bone adding but little to the danger, while severe comminution reduces the prospects of success to a minimum.

In compound fracture into the ankle-joint without displacement no operation is usually called for, since good results are obtainable by conservative treatment.

In compound fracture of the shoulder- and elbow-joints amputation is rarely required unless the parts are irreparably crushed or the patient is so old as to forbid any hopes of recovery being entertained. Yet in many cases excision should be undertaken, as it is wiser to excise the articulation at once, with the view of securing movement, than to look for a recovery by natural processes where anchylosis must be expected, unless, indeed, the wound is small, the injury to the bones slight, and the patient young.

In compound fracture of the wrist no operation is required, as a general rule.

Summary.—By way of summary, compound fractures into joints should be regarded as cases of wounded joint and treated accordingly, the amount of bone comminution and displacement having an important influence in determining the question and nature of operative interference when such may be called for.

In large joints, where excision is inexpedient or dangerous, amputation must be had recourse to; in others, where excision is a sound operation, it should be preferred. In the ankle- or wrist-joint, where the articular ends of the bones project, they should, except in young subjects, be removed.

Comminution of bones is a complication that requires a few observations, although in *simple* fractures it does little more than render difficult the treatment of the case and increase the risk of some shortening or deformity. When, however, it is the result of a direct force from a "spent ball" or other projectile, the comminution may be very great; the bone also may be fissured and with the soft parts contused, the danger of the case under these circumstances being much aggravated, not only from the direct effect of the injury, but from the ostitis that is so liable to follow.

In *compound* fracture bone comminution has, too, an important influence for harm, adding greatly to the risks and dangers of suppuration and diminishing the probabilities of a successful result, since each piece of bone often acts as an irritant and retards recovery, and the fragments too often subsequently die. It is always well, therefore, in these cases to remove the detached portions, and when the extremities of the bones are ragged to excise them. Large pieces of bone, however, that are held by their periosteal coverings must not be interfered with. This splitting and comminution of bone is most frequently met with in gunshot wounds, the conoidal bullet of the present day splintering far more than the round one of former times.

In all cases of compound fracture where difficulty is experienced in reducing the projecting ends of the broken bone the best course is to remove them with a saw, particularly when they are sharp; comminuted fragments should also be taken away. When much bone has, however, been removed, the surgeon should be careful not to separate the parts too much, for fear of want of union.

The subject of dislocation and fracture has been discussed in the chapter on dislocation.

Fracture from gunshot wounds will receive attention in the chapter devoted to gunshot injuries.

CHAPTER XXXII.

DISEASES OF THE JOINTS.

General Remarks.

To assert that safe and scientific surgery can only be based on sound pathology may appear to be a somewhat trite observation; nevertheless, it is true—so true, indeed, that it cannot be impressed too forcibly on all who seek or profess to practise our profession. Moreover, it should be the aim of every surgeon whose duty it is to practise and to teach to demonstrate the truth of the assertion and to establish his practice upon such a scientific basis. It is with this feeling that I now propose to consider the pathology of joint disease and to explain briefly the changes which the tissues undergo during inflammation and the results to which those changes lead, setting aside for the present disputed points of pathology and reserving for future consideration the subject of tumors involving joints.

Diseases of a joint generally commence as an acute or chronic inflammation of the bone or synovial membrane, although in the progress of any case, and particularly when disorganization of a joint has taken place, both tissues become affected, the extent to which either will be involved greatly depending upon the seat of the original disease. When it has begun in the synovial membrane and gone on to produce disorganization of the joint, the bones will in all probability be found to be affected only on their articular facets; the deeper structures will not have been involved. When the bones are the original seat of the mischief, and the inflammatory process has spread from them to the synovial membrane and disorganization of the joint taken place, the chief pathological changes will be seen in the osseous tissue, and either the whole or a part of the articular epiphysis, if not a portion of the shaft, will be involved in the disease. Under both circumstances the cartilage covering the articular facets will have disappeared. When the bones are the primary seats of disease, the cartilages are shed more rapidly, as the articular cartilages derive most, if not all, of their nourishment through the bones; and, as a consequence, any perversion of nutrition and inflammatory changes of this tissue at once show themselves in the cartilages.

Practically, there is no such thing as a primary disease of the articular cartilages, no such process as so-called ulceration of cartilage, independently of disease of other tissues. When the cartilages undergo a change, it is always secondary to some affection either of the synovial membrane, when it is slow and partial in its action, or of the bone, when it is rapid and complete. It should be remembered, however, that disease in the synovial membrane of a joint cannot exist for any time or be of any severity without involving its ligaments or the cellular tissue with which it is surrounded. Nor can inflammatory disease exist for any period in the articular extremity of a bone without more or less affecting its periosteal covering. It should be added, too, that there is good reason to believe that either bone or synovial disease may be started by a severe sprain or laceration of ligaments at their osseous or periosteal attachments.

Before proceeding to consider the changes the different tissues undergo from the inflammatory process, it will be well to ask whether there is such a disease as strumous disease of a joint, strumous disease of the synovial membrane or bone.

If I were to answer this question according to custom, as indicated by the free application of the term to joint disease, I should unquestionably say that it was a common affection; for there are few chronic changes of a joint that are not so designated, and it is rare, in a delicate child, to meet with any chronic affection of a joint which is not regarded by some as a strumous disease. Indeed, from the constant use of the phrase, it might be thought that the term "strumous disease" had some definite meaning or conveyed some definite idea—that the affection so designated was of a special kind, could be recognized by special features, and possessed definite pathological characteristics. Yet it can hardly be said that such is practically the case; for if we look for the points of difference between the so-called strumous disease and the chronic inflammatory affections, we shall fail to find them, since they are not clinically to be distinguished or practically to be separated. Indeed, I am more than satisfied that the so-called strumous disease of a joint is nothing more than a chronic inflammation of the bones or the synovial membrane, or both, that the pathological changes in the affected tissues are such as are clearly traceable

to a *low form* of inflammatory action, and that they differ in no single pathological point from the inflammatory changes found in other parts. It is true that such affections, being of a low type, differ from other inflammatory actions of a more healthy character, but that they are, nevertheless, inflammatory there can be no doubt. Practically, therefore, it would be well to expunge this term "strumous" in respect to joints from our vocabulary, as its use certainly misleads by making the student believe that the term has a definite meaning when it has not, and by encouraging the idea that the disease to which it is applied has a constitutional more than a local origin, and is consequently incurable. Of this, however, I am sure—that so-called strumous disease of a joint is as curable and as amenable to treatment as any other chronic inflammatory disease. In saying this, however, I do not dispute the fact that pathologically we do at rare intervals find tubercular deposit in some of the tissues building up a joint, and particularly in the bone; but I must repeat what I wrote many years ago in my work on diseases of the joints—that "such preparations, being so rare, are to be regarded as pathological curiosities." They are discovered also accidentally, and cannot be clinically recognized by any characteristic features from other cases of chronic inflammation of the bone. It would be well, therefore, to give up the term in scientific discussion, or, if it be used at all, to use it in the same sense as the words "tumors," rheumatism," and "fever" are now employed—as a broad general term that includes many affections and covers much ignorance.

With these general remarks, I now pass on to consider the changes the different tissues entering into the formation of a joint undergo in the inflammatory process.

Pathological Changes which take Place in the Synovial Membrane from Inflammation.

In a pathological point of view, inflammation of the synovial membrane may show itself in two distinct ways—firstly, in change of function; secondly, in change of structure. The first change may take place without the second, but the change of structure necessarily includes an alteration in the function. The best examples of the first class of cases, in which a change of function is the most prominent point, are seen in every-day practice in cases of so-called chronic or subacute synovitis, where excess of secretion in a joint is the main symptom, and in which this secretion may be reabsorbed and leave no trace of disease behind; whilst the best illustrations of the second class, in which change of structure is the main point of clinical as well as of pathological importance, are seen in the pulpy disease of the synovial membrane. Between the two great classes of cases, however, there are doubtless many links; for example, in acute synovitis we have change of structure even to more or less complete disorganization, and in chronic synovitis frequently repeated we have change of structure such as gradually pases into the pulpy synovial disease. It would thus appear that in acute inflammation of the synovial membrane we have pathologically a series of changes that differ somewhat from those seen in chronic inflammation, and that while the acute form, it is true, passes into the chronic by imperceptible gradations, the two classes of cases are, nevertheless, very distinct. Acute inflammation of a synovial membrane in its early stage is pathologically represented by what my notes of cases clearly illustrate—a more or less minute injection of the capillary vessels, passing on to a velvety appearance of the synovial surface, a flocculent surface or one covered with fine fringes of lymph, while in the more acute cases the synovial membrane may have disappeared by ulceration or sloughing or have so softened down as to be destroyed on the slightest touch. In the former class of cases there will be, clinically, increase of secretion in the joint, severe local pain, and heat with surgical fever; while in the latter there will be acute suppuration and the synovial membrane may show any one of the conditions already indicated, or they may have disappeared, pus and broken-up membrane alone remaining to indicate the local severity of the action as well as the destructive nature of the affection.

In intermediate or less acute cases other changes may be seen, but they are not less marked. In one, the notes of which are before me, there was visible to the eye a local patch of capillary injection, and beneath it could be made out a superficial granular change of structure in the cartilage, In another an effusion of a firm fibrinous layer of lymph over the surface of the synovial membrane and articular cartilage showed itself, and this membrane could be raised from its bed and peeled off—not only off the synovial capsule, but also off the articular cartilage; and beneath this membrane fine radiating capillary vessels passing from the margin of the articular cartilage toward the centre were clearly visible. In this case, moreover, after a section was made through the spot

of injected membrane and cartilage down to the bone, the swollen layer of membrane passing over the cartilage was clearly visible, as well as the granular degeneration of the cartilage beneath; and this membrane could be separated from its cartilaginous connection by means of needles. It occurred in a child, but it seems to me to be sufficient to prove by means of pathology what anatomy has hitherto failed to settle—viz., that a layer of membrane passes over the articular cartilage. I have seen these changes more than once.

The changes that take place in the synovial membrane in subacute and chronic synovitis remain to be noticed, and they are essentially of the same pathological character as those we have been just considering, though they differ in this great point—that the synovial membrane is not destroyed, but becomes thickened in various degrees by the infiltration within its walls and upon its surface of inflammatory product; and this thickening may be so great that the synovial membrane may be represented by a tissue an inch in diameter. It will, however, be found only in cases in which repeated attacks of inflammation have taken place and many layers of lymph have been deposited upon and in the affected tissue. The layers may not be deposited rapidly one after another by consecutive attacks of chronic inflammatory action—for they may be the result of disease which has spread over many years—but they will always represent an inflammatory action of a chronic nature which at uncertain intervals has attacked the joint, and on each occasion left behind it pathological evidence of its presence by an inflammatory infiltration. In delicate and so-called strumous subjects the product will be soft and pulpy, and in the syphilitic firmer and fibrous.

It is with such changes as these that all cases of the gelatiniform or gelatinous disease of the synovial membrane, as well as the pulpy disease of Sir B. Brodie, are unquestionably to be classed. Both are of the same nature pathologically and clinically—at least, all my own investigations have led to this conclusion. I shall therefore employ the phrase "pulpy disease of the synovial membrane" to designate the changes which ensue in chronic inflammatory synovial disease. The term is short and as expressive as any other, besides being one with which the profession is familiar.

Pathological Changes which the Articular Cartilages undergo from Disease.

The most important point the practical surgeon should recognize when considering the pathology of the articular cartilages has reference to the fact that there is no primary disease of its structure, since pathological anatomy teaches us that all the changes found in it are secondary to some other affection, and, in the generality of cases, to disease in the articular extremities of the bones. There is no such disease, therefore, as primary "ulceration of the cartilages," and when the cartilages are diseased, they are so from the extension of mischief from the bone beneath or from the synovial membrane around or upon them.

Much has been written about the cartilages under the idea that they were liable to special diseases, and much error has consequently crept into joint-pathology, the authority of great names such as Brodie, Key, and others having helped to encourage this idea. Modern investigation, as carried out by Redfern, Goodsir, and others, has, however, corrected this erroneous notion, and an improved pathology has clearly shown that the diseases of the cartilages are secondary to diseases of other tissues.

Some years ago, when describing the results of my own investigations, I divided these affections into the *fatty*, the *fibrous*, and the *granular* degenerations, and nothing that has been observed since has led me to doubt the accuracy of this classification; indeed, additional experience has confirmed its truth. I am not about to enter, however, into a minute description of the different changes, for they can be read elsewhere; but it may suffice for my present purpose to remind the reader that the *fatty degeneration* of the articular cartilages is found in joints that have been deprived of their natural functions from any cause—from non-use in the majority of cases, but in many from bad nutrition; that it is found in common with the same change in the bones or other tissues. This fatty degeneration can be recognized with tolerable facility by the naked eye, for the cartilage so affected, instead of possessing its natural white pearly aspect, will appear somewhat transparent, with an undulating, unequal, although smooth, surface. When cut, it will feel softer than usual, and may be three or four times its natural thickness. At times it may even be "pulped" by firm pressure with the finger, and be separated from the bone with more than usual facility. Microscopically, also, it will present characteristic features. The natural cartilage corpscules will have become changed into fat and

granule cells in various degrees, and the hyaline matrix will be filled with cavities varying from the healthy standard to large spaces. These spaces, moreover, will be filled with the elements of fatty degeneration, into which the healthy corpuscles will have changed. This fatty degeneration takes place in most joints that have not been used, but rarely from disease of the joint itself. When, however, a joint so changed becomes the subject of inflammation, disorganization of the articulation rapidly follows; for such a degenerated tissue has no power of resisting disease and disappears when attacked by it rapidly.

The **fibrous degeneration of the articular cartilage** is a disease of a peculiar character. I believe it to be associated with only one disease of a joint, which is "osteo-arthritis." It is very gradual in its progress and is not characterized by any definite symptoms. It can be recognized pathologically in its earliest stage by the loss of the natural glistening aspect of the cartilage of a joint, the smooth surface of which disappears and looks rough. Small fissures involving more or less of its thickness next appear, which sometimes extend down to the bone, and, as a rule, are thicker in the centre; they occasionally radiate outward. The cartilage seems gradually to become thin, and after a time to disappear, exposing the articular surface of the bone, which probably will have undergone the calcareous degeneration. Microscopically, the principal change that is seen in this disease is the gradual alteration of the hyaline structure into fibre. The cartilage corpuscles at the first will be found interspersed between these fibres, but at a later date to have changed into granules. At the last stage nothing but fibres may be found; and when this condition exists, the total and rapid disappearance of the structure will not be far distant.

The **granular degeneration of the articular cartilage** is the most important affection of this tissue. It is the one most commonly found in joint affection, and seems to be the direct consequence of a perverted nutrition in the bone or synovial membrane from disease of these structures. Though of a simple nature, it shows itself in many ways, and without microscopical investigation it must have appeared unintelligible. In its different forms it has doubtless led good observers to describe it as an ulceration of cartilage, for under certain conditions the cartilage presents a worm-eaten, excavated appearance not unlike that which ulceration might produce.

The disease is essentially a granular degeneration, first of the natural cartilage cells imbedded in the hyaline matrix, and secondly of the hyaline matrix itself. Let a cartilage cell undergo this granular degeneration, and the granules by accumulation and multiplication form a cavity in the hyaline matrix. Let this cavity burst on the surface of the cartilage into the joint, and an excavation is formed which can be seen by the naked eye, and a so-called ulcer is produced. Let this change take place toward the margin of the articular cartilage, and we find an explanation of Mr. Key's observations upon so-called ulceration of this tissue in certain forms of inflammation of the synovial membrane of the joint. Let this change take place near the bones as a result of disease in their articular ends, and we find an explanation of the general condition of the cartilages in the bulk of joint diseases; for when the bones entering into the formation of a joint are so affected as to interfere with the nutrition of the articular cartilages, the cartilage may either present the worm-eaten appearance all over or in part, or it may have been shed from its bony attachment, when it will be found to be lying upon the bone as a foreign body in the joint. In an early stage of disease this granular degeneration may be detected only by a microscopical examination, although when it follows upon disease of the bone the cartilage will always be found to peel from off its articular facet with unusual facility.

In synovitis, also, the surface of the cartilage in contact with the inflamed membrane will be found similarly involved. Should the disease be local, as is at times seen in cases of injury to an internal ligament such as the ligamentum teres, the change in the cartilage will be local only; but when general, the whole surface of the cartilage may be involved. In acute disease acute degeneration follows, as is evidenced by daily practice.

Pathological Changes in the Bones the Result of Inflammation.

Inflammation of the articular extremities of a bone is a very common disease—probably the most common we have to deal with in connection with joints; for it would appear to be the cause of most, if not of all, of those cases of disease of the articulations which we find in children and have been described as strumous or scrofulous disease of a joint. Some years ago, when writing on this subject, I stated that "I cannot for one moment doubt that the majority of the cases which are described by surgeons as strumous or scrof-

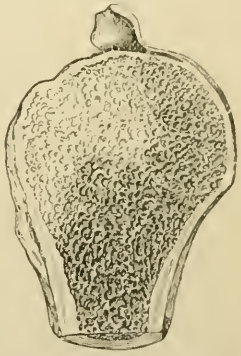
ulous disease of a joint of the articular extremities of the bones depend upon a chronic inflammation in the bone," and all the experience I have since gained has tended to confirm me in this opinion. I believed then, as I believe now, that the disease in its origin and progress is inflammatory, and that it is as curable as any other local affection. It is important to bear this invariably in mind when examining or treating a case of disease of a joint, particularly when it is found in a so-called strumous or cachectic subject; for if we regard the disease as a constitutional one, we are apt to think it ought to be treated on general principles, and to neglect the local means by which alone a good recovery can be secured.

Let us now inquire into the changes that the bone undergoes during this inflammatory or wrongly-called strumous affection.

The most striking is probably the earliest, which is the expansion of the articular extremity; and in some cases this will be very great, and generally uniform. The articular extremity of the affected bone or the epiphyses of all the bones entering into the formation of the joint will appear to be rounded and generally enlarged. Upon making a section of a bone thus affected it will be found softer than natural; indeed, it may be so soft as to allow a knife to divide it, or even to break or crush it on firm pressure. To the eye the section will appear more vascular than natural, the cancellated portions more cancellated, the cells enlarged, and the bony septa radiating from the shaft in a broad, palm-like fashion. The cells will also be found filled with a pinkish serum.

If the disease continue and the inflammation be of a healthy type, parts of the bone will appear denser and more indurated than the remainder; its cancelli will be filled with inflammatory products which have organized, and the bone will appear on section as a dense and apparently bloodless mass surrounded by other vascular cancellated tissue. Should the inflammation be of an unhealthy character, diffused suppuration within the bone will take place, and death of the bone, wholly or in part, follow. Under these circumstances the disease will probably have become a genuine joint affection, and have extended to the synovial membrane of the joint and set up disease within its substance. This extension of disease will show itself by effusion within the joint, by pulpy thickening of the synovial membrane and of the cellular tissue around the articulation. Up to this point the disease has been local, involving only the articular extremities of the bones, and has not attacked the proper joint structures, and appears also to be perfectly curable. But at this stage of the disease the articular cartilages will have become affected; for when the inflammatory action has continued for any period and not shown any indications of subsidence, but, on the contrary, has either assumed an unhealthy character or interfered with the nutrition of the articular lamella of bone upon which the cartilages rest, the articular cartilage will to a certainty undergo a granular degeneration upon the surface in apposition with the bone, become loosened from its attachment, and be thrown off or shed (Fig. 599); or it may degenerate in patches and present to the eye an irregular excavated surface. If the disease be chronic, the cartilage will degenerate slowly and be as slowly loosened from its osseous base, when it may readily be lifted off the bone by any instrument. If the disease be more rapid, the cartilage will likewise be shed more rapidly, raised as a blister off the bone, or found lying upon it as a foreign body. Under the microscope it will appear to have undergone the granular degeneration.

FIG. 599.



Drawing (G. M. 30306) made to show the Shedding of the Articular Cartilage in Ostitis.

When the disease is acute, the cartilage may disappear altogether, having been shed from its osseous base and become rapidly degenerated.

The articulating surface of the bone during this time may appear in some cases, as in inflammation, only extravascular; in others it may be rough or so-called ulcerating; while in a third class the articulating facets will have been shed wholly or in part. In a still worse class pieces of necrosed bone involving more or less of the articular extremity will be seen, while in the worst an abscess will have made its way into the joint from the diseased articular extremity. In all these conditions the cartilages will have disappeared and the joint become disorganized.

FIG. 600.

Transverse Section of the Humerus above the Condyles, showing New Bone deposited beneath Periosteum, undergoing Rarefaction and thus simulating True Bone Structure. (Taken from a specimen of Mr. J. Poland's.)

These pathological remarks

are applicable to every articulation—to the hip as much as to the knee, and to the shoulder as to the elbow.

In all chronic cases of ostitis there will be found more or less deposit upon the bone underneath the periosteum, and some good surgeons believe that it is solely by such deposit that the clinical symptoms of enlargement of bone are to be explained. My friend Mr. C. Symonds has ably supported this view (*Brit. Med. Journ.*, December 8, 1883).

The drawing (Fig. 600) shows how subperiosteal bony formations subsequently rarify, so as to simulate true bony enlargement, the cancellous appearance being due to the widening of the canals in the compact tissue through absorption of the bony walls.

Clinical Symptoms associated with these Pathological Changes.

The symptoms by which these pathological changes which have been described can be recognized vary according to the formation and surroundings of each joint, but in their general character they are the same.

Any **inflammation of the synovial membrane,** of whatever kind, always shows itself within a few hours or days of its origin by effusion, and consequently by distension of the articulation, while in the knee, ankle, elbow, wrist, shoulder, and other joints this clinical condition makes itself manifest in a way which cannot be misinterpreted. The synovial sac becomes enlarged and distended by the effusion, so that it bulges between the bones and gives an outline to the joint unlike that furnished by any other condition. In the hip-joint similar changes take place, but they are not quite so palpable, though they can be made out by careful examination, and particularly by a comparison of the affected with the sound side—a point of practice which should never be omitted in the examination of any injured or diseased joint; the soft parts in front of the joint will be more prominent and full; pain will be produced by gentle pressure made upon the part, particularly behind the great trochanter, where a soft swelling, which will be manifest to the eye, will also exist in lieu of the natural depression. Even fluctuation may be detected through the joint on careful palpation. At any rate, to the eye and hand there will be clearly some extra fulness of the soft parts sufficient to lead a surgeon to suspect the true nature of the disease.

In **disease of the articular extremities of the bones** a different clinical condition will be present. At the commencement of the disease, and sometimes for a lengthened period, which varies in each case, an aching of the part is the only local symptom. This aching may be of greater or less intensity, and depends much on the severity of the disease. It is too often regarded as "growing pains" or rheumatism. What I wish now to note is that local pain is the first clinical symptom, and not effusion, and that there is no enlargement of the affected joint. As the disease progresses, however, an enlargement may be detected, which in the hip can be made out by manipulation, whereas in the knee or other joints it may be visible to the eye. It will show itself as an apparent enlargement of the bone, a thickening or expansion of the osseous, and probably of the periosteal, structure unlike that existing in synovial disease; there will be no fluctuation, no soft yielding of the parts, but clearly a thickening of the osseous structure of the articular extremity of the bone, while the soft parts covering in the enlarged bone are quite natural. With this aching of the part there may also be increase of heat as an early symptom, yet this symptom is not constant, although it is fairly uniformly so; it may, however, be intermittent. As a rule, it shows itself as a general periodical flushing of the part.

In **chronic synovitis which leads to joint changes** the joint may probably be gently moved without exciting pain or spasm of the muscles that move the articulation. Pressure upon the part with the fingers will probably excite it, although moderate pressure of one bone against the other may be made without giving rise to any indication of distress.

In **diseases of the bone entering into the formation of the joint** these clinical conditions do not all exist. The joint may be moved quietly without exciting pain, but the attempt will, as a rule, excite spasm of one or more of the groups of muscles which move the articulation. Moderate manipulation also will be well borne. Firm pressure upon the bone, so as to bring the two articular surfaces in contact, will always excite pain; not the pressure produced by a jar, such as in the hip is caused by a sudden blow upon the foot or trochanter—for such a mode of investigation must be

looked upon as rough and somewhat uncertain; indeed, it is almost sure to excite in the patient a start and an expression of pain—but the pressure which is produced by a steady force applied by the hand to the trochanter toward the pelvis or through the foot to the articular extremities of the bones; a pressure which in synovial disease rarely, if ever, gives rise to pain, but in osteal disease invariably excites it.

These symptoms in the two classes of cases appear clearly to indicate the two distinct affections in their early stage. They apply to all articulations, and may be thus summarized:

Summary.—In **synovial disease** swelling is the earliest clinical symptom, with more or less fluctuation, each joint showing this in its own way. As a rule, this swelling is unattended with much pain. Pressure on the joint causes pain, although gentle movement may be made without increasing it or exciting spasm of the muscles which surround the joint. Inter-articular pressure can generally be tolerated.

In **articular ostitis** pain is the earliest and most constant symptom—pain of an aching character, varying in intensity and generally increased by firm local pressure. There will be no visible enlargement of the part for some weeks or months, and no fluctuation. Gentle movement generally excites spasm of muscles about the joint, and inter-articular pressure always increases this and causes pain. Increased heat also exists about the parts and is of an intermittent character.

DISEASES OF SPECIAL JOINTS.

Disease of the Hip-Joint.

Authors have hitherto led their readers to look upon disease of the hip-joint as a special or peculiar affection, and to regard it pathologically and clinically as distinct from diseases of the other joints. Such, however, is not the case, for diseases of the hip-joint differ in no single pathological point from those of any other articulation.

It has also with too much confidence been described as a "strumous disease," as if all diseases of the hip-joint or of any joint were generally of this nature or found in subjects who are only of a strumous diathesis—as if all had a constitutional, and not a local, origin.

Hip-joint disease is a local disease and is mostly set up by local causes. It is, moreover, as amenable to local treatment as any other affection. "It occurs very frequently in strumous children," says Mr. Holmes—"a circumstance which has led to its being denominated 'strumous;' but it seems to have no necessary connection with struma, unless so wide a signification be assigned to that somewhat vague term as would render the designation itself unmeaning. If by struma be meant a state of the system which renders the subject of it prone to the deposit of tubercle in the viscera, I think that there is good reason for asserting that morbus coxarius often attacks children who are not strumous—*i. e.*, who do not display any such tendency to the deposit of tubercle—and therefore that no decisive proof of any strumous tendency is afforded by the presence of the affection. If, on the contrary, struma be defined as that condition of the system which disposes its subjects to the development of low inflammations of various kinds, then it is difficult to see what is the significance of the designation." It would, therefore, be well to discard the erroneous notion that hip disease has its origin in a constitutional cause, for till that is effected the local treatment is likely to be disregarded or looked upon as of secondary importance, whereas all who have much experience in the treatment of these cases will admit that local treatment cannot be made too prominent a feature. It should, therefore, be looked upon clinically as a local affection and one to be treated by local means, such constitutional treatment being employed as the general condition of the patient may appear to warrant, the same principles of practice being applicable in these cases as have been found of value in other joint affections.

Hip disease, unfortunately, is a very common affection, and my own statistics inform me that it forms about thirty per cent. of the joint cases admitted into a metropolitan hospital. It is also an affection of child-life, for out of 360 cases of which I have notes, 62 per cent. or nearly two-thirds, occurred in children under ten years of age, and four-fifths in patients under twenty—that is, it occurred during the period of the growth and development of the bone, and not during that of its full maturity. This point will be seen on reference to the following table:

Table showing the Ages at which Hip Disease commenced.

Four years and under	126 cases	223 cases, or 61.9 per cent.
Between 6 and 10 years of age	97 "	
" 11 " 20 "	86 "	or 23.8 per cent.
" 21 " 30 "	27 "	or 7.5 "
" 31 " 40 "	13 "	or 3.6 "
Above 40 years of age	11 "	or 3 "

Of these cases, 230 were collected by me when acting as registrar at Guy's from 1853 to 1861, and 130 are from the notes of cases which have been under my own care.

It is found in the male and female subject in equal proportions, but appears to attack the left more frequently than the right limb, sixty per cent. of my cases having occurred on the left and forty on the right side; and this proportion is very similar to that published by Mr. Lonsdale in the *Lancet* for September 8, 1855, where, out of 112 cases of deformity of the hip, 65 were of the left and 47 of the right side.

Pathology.—It has been already stated that in a pathological point of view hip disease differs in no respect from that of other joints and is not a strumous affection, although it may occur in strumous subjects. It may also be repeated that it is a very rare thing to find strumous or tubercular matter in a diseased hip-joint. Excluding new growths, disease of the hip consequently means inflammation of the bones or soft parts entering into the articulation, and in at least two-thirds of the cases inflammation and necrosis of bone.

In the pathology of joints few points probably have been more disputed than the seat of the disease in hip-joint affection, and I believe the difficulty has been entirely raised on the mistaken notion that the nature of the affection was different from that of other joint diseases. We have never heard much importance placed upon the point in diseases of the knee-, shoulder-, or other joints. The question as to the origin or not of disease of the knee in the crucial ligaments or of disease of the shoulder in the long tendon of the biceps has never been very warmly discussed. And yet we find men gravely discussing the question as to the origin of hip disease in the ligamentum teres. My much-respected teacher, the late Mr. Aston Key, laid great stress on this point, and believed that it was from that ligament and its attachments that disease of the hip-joint generally proceeded. Pathology has, however, made great advances since those days, and we now know that disease in a joint (hip or other) may have its origin in the bones which form the joint or in the soft parts or ligaments that hold them together. Experience, moreover, has taught us that we may have an acute inflammation of the synovial membrane rapidly going on to complete disorganization of the ligaments, cartilages, and soft parts of the joints, and even causing death of the bones entering into its formation. The inflammation may be so acute as to render it difficult at the post-mortem examination to read the pathological facts correctly; for when such changes as these take place, it is fairly open to question whether the inflammation originated in the synovial membrane and spread to the bones, cartilages, and ligaments, causing their destruction, or whether it began in an osseous centre and extended to the joint. This difficulty is experienced when the disease has been so severe as to cause a division of the pelvic bones into their original segments or a separation of the epiphysis of bone forming the head of the femur from its normal attachment to the neck.

When the bones of the joint are equally involved in acute disease, it is probable that the mischief began in the synovial membrane and spread to the bone. But when we find one bone more diseased than another—*e. g.*, the femur than the acetabulum, or *vice versâ*—it is probable that acute inflammation originated in it and spread to the soft parts. These points, however, are to be looked upon as only feeble indications, and not as definite guides upon which an opinion may be formed. In chronic disease of the hip-joint the question as to the seat of the original disease is not so easily answered, and yet, from what I have observed, clinically and pathologically, the question is not one impossible to answer. When a joint is disorganized, its ligaments and cartilages gone, and the articular surfaces of the bone exposed, or perhaps diseased, there may be some difficulty in deciding as to the particular tissue in which the inflammation originated; but when a section of the bone is made—*e. g.*, the head of a femur or the head of a tibia—and a cavity, a sequestrum, or a suppurating bone is found communicating with the joint, probabilities certainly point to the bone as being the original seat of the disease. But it may be asserted that in such instances no one doubts the cause of the joint disease, since the pathological conditions clearly prove it; yet the clinical histories of such cases differ in no single point from those of others in which, perhaps, the same very marked evidence

of disease is not to be seen—that is, if the joint be examined on its surface only. Indeed, to examine a pathological specimen of a bone or of a diseased joint, it is absolutely necessary to make a vertical section through the bone, since to look at it from the joint surface is most fallacious and an opinion formed from the appearance thus acquired is too likely to be erroneous.

If we make, then, a section of the bone in chronic disease of the joint, we shall find in a large number of cases, especially in the young, hyperæmia of its articular extremity and condensation, if not suppuration or necrosis, from chronic inflammatory action (Fig. 601); in fact, we shall find marked evidence of articular ostitis in one of its stages, for doubtless during young life this is the most common form of disease which precedes joint mischief and from which joint disease proceeds. This opinion is also corroborated by the fact that in our museums almost every specimen of chronic joint disease reveals advanced bone mischief extending beyond the surface and generally involving more or less of the articular ends of the bone which enter into the formation of the joint. In our Guy's Museum this point is very strongly displayed, and on looking over other museums and copious notes of joint cases the same truth is apparent.

At times, however, the disease may primarily commence in the epiphysial cartilage situated between the head of the femur and its neck, the epiphysis as a consequence being thrown off (Fig. 602). This pathological observation must be looked upon as of

Fig. 601.

Necrosis of the Head of the Femur, with Sequestrum in its Neck. (Prep. 1318⁵, Guy's Mus.)

Fig. 602.

Separation of Epiphysis forming the Head of Femur. (Guy's Mus., Prep. 1315⁵⁰.)

great clinical importance; for if the majority of cases of joint disease is to be attributed to the extension of an inflammatory action from the articular extremity of a bone to the other tissues, it becomes a question of urgency to recognize the disease of the bone in its early stage in order to prevent its progress to the tissues upon which the integrity of the joint itself depends, and clinically there is good reason to believe that such can frequently be done. In the hip-joint it may be difficult—possibly more difficult than it is in disease of other articulations that are not so well covered in with soft parts, such as the knee—but it can be made out with care and discrimination even in the hip. And here it may be well to consider the clinical features upon which our diagnosis should be determined.

Diagnosis.—The necessity of making a correct and early diagnosis of hip disease would scarcely require illustration did not daily experience indicate that it is not sufficiently recognized. The early symptoms of the affection, consequently, are important.

When a child, after injury to the hip, has joint pain, and possibly limps, and these symptoms persist after all external evidence of injury has passed away, there is some reason to suspect the presence of joint mischief. When this pain is increased by inter-articular pressure, either by means of the hand applied over the trochanter or by the patient standing or walking, the suspicion should be strengthened. When swelling of the parts can be made out and some bulging of the synovial membrane, as shown by a fulness behind the trochanter and in the groin, is found to exist, combined with tenderness, synovial inflammation is rendered probable; and when persistent pain without effusion is the more prominent symptom, aggravated by firm inter-articular pressure, bone mischief is indicated. When these symptoms appear after some fever or illness—or, indeed, without any such cause—they are of no less importance, although, probably, they are more liable to be overlooked.

As a clinical point of primary importance all joint pain claims attention, and particularly in hip-joint cases; and when this is referred to the knee, the surgeon must not be misled. *Limping* of any kind always indicates something wrong—probably very wrong—more particularly when combined with joint pain aggravated by inter-articular pressure.

Spasm of the muscles around the joint is a symptom of great significance and a means that nature adopts to ensure immobility of the affected articulation; in some cases it will be so severe as to forbid all movement, but in others it is less marked; at one time it will be confined to one group of muscles, such as the flexors, when the position of the limb will be determined, while at others the rotators or abductors will be affected: but whenever it is met with, there is probably some affection of the joint itself or of the bones that enter into its formation. When doubt exists as to muscular spasm being the cause of joint immobility, an anæsthetic should be used, as all spasm ceases under its influence, and the head of the bone, by manipulation, rotates with more or less facility and smoothness according to the amount of joint mischief that is present.

Position of Limb as a Means of Diagnosis.—In the diagnosis or treatment of hip disease there is no point which deserves closer attention than the position of the limb, and I am disposed to think it has not received that attention, since experience has proved that most of the cases of deformity met with after a natural cure of the disease are due to a want of appreciation of its importance.

In one case the limb will appear elongated, but on measurement no real lengthening will be detected, the apparent elongation being due to the tilting upward of the pelvis on

FIG. 605. FIG. 606.

Apparent Shortening of the Limb in Hip Disease caused by Adduction.

FIG. 603. FIG. 604.

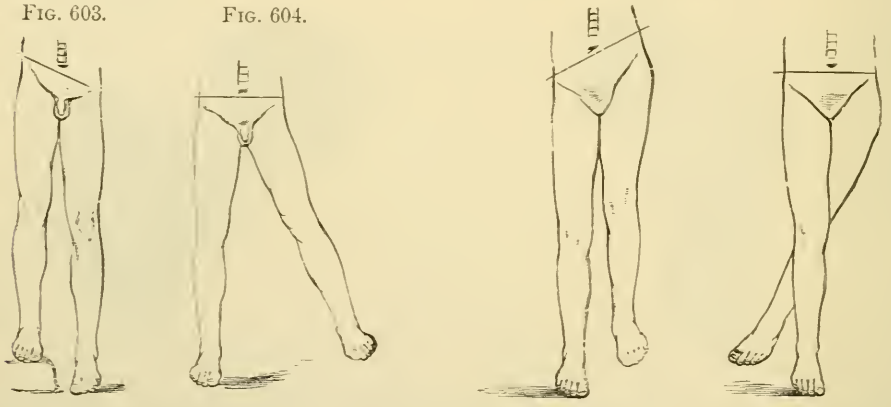


Fig. 603.—Apparent *Elongation* of the Left Lower Extremity in Hip Disease on the Left Side, due to *Ab*duction of the Limb and the necessary Tilting Upward of the Pelvis on the sound side to allow the Abducted Limb being brought into a Line with the Body.

Fig. 604.—*Ab*ducted Position of the Diseased Left Limb when the Pelvis has been brought into its Natural Position at Right Angles to the Spine.

Fig. 605.—Position of Patient when Standing with Disease of the Left Hip-Joint and an *Ad*ducted Limb. (The pelvis is tilted up on the affected side and the limb thereby apparently shortened.

Fig. 606.—Position of the Adducted Limb when the Pelvis is brought Straight.

the *sound* side, either from the patient naturally throwing all the weight of the body on that side to take off pressure from the affected one or from muscular spasm causing abduction of the limbs (Figs. 603, 604). In another case the pelvis on the affected side will be drawn up and tilted slightly backward, the thigh becoming adducted and more or less flexed upon the pelvis (Figs. 605, 606), or in some cases rotated outward from the spasmodic contraction of the muscles that move the hip. In other and more advanced cases genuine shortening of the limb may take place from either real loss of substance in the head or neck of the bone, or, in exceptional cases, from dislocation of the head of the femur upward and backward (ilio-ischiatic); and in rarer examples the neck and shaft of the femur may be separated and displaced upward and backward, the epiphysial head of the bone being left in the acetabulum. This probably occurred in the case from which Figs. 607, 608 were taken. Where the joint is flexed, some spinal deformity (lordosis) will exist when the patient stands or lies; but this apparent spinal curve will, however, even in the worst cases, at once disappear when the patient is placed on his back and the limb raised (Figs. 609, 610) or

FIG. 607. FIG. 608.

Displacement of Femur. (Taken from William D——, æt. 9, following disease of five years' standing. There was some movement in the joints.

when he stands with the leg flexed (Fig. 612). Apparent elongation of the limb under all circumstances means its *ab*duction; shortening of the limb implies *ad*duction; flexion

Fig. 609.

Fig. 610.

Fig. 609.—Lordosis of Spine, as seen with Patient the Subject of Hip Disease in Recumbent Position, with Femur flexed at Angle of 130 degrees.
Fig. 610.—Lordosis Effaced by Elevating the Flexed Limb.

gives rise to *lordosis*. These conditions necessarily follow any attempt of the patient to bring the sole of the malplaced limb down to the ground.

Flattening of the nates, as seen in hip disease, is due to a wasting of the glutei muscles from want of use, this symptom becoming more marked when the thigh is slightly flexed, the trochanter rotated outward and the foot inward.

Disease of the Hip-Joint attended with Suppuration.—These are the worst cases of joint disease, for suppuration of a joint generally means its disorganization; and when the disease has its seat in the bone, necrosis or some serious inflammatory change is indicated. Under these circumstances all free movement of the head of the bone will probably have long disappeared and more or less anchylosis or natural repair have taken place, for in joint affections reparative and diseased actions run much together. The limb may be found in any position, the flexed and adducted position of the thigh being the most common, particularly in neglected cases, as illustrated in Fig. 613; but at times the thigh will be rotated outward, and even abducted. When sinuses exist, a probe may detect diseased bone. When the pelvis is involved in the disease, a finger

Fig. 611.

Fig. 612.

Lordosis of Spine in Hip Disease from Flexion of Thigh.

Fig. 613.

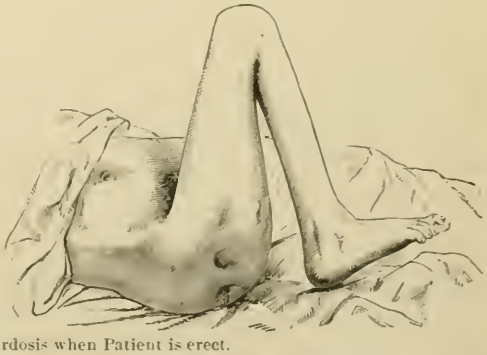


Fig. 611.—Anchylosis of Left Hip at 130°, producing Lordosis when Patient is erect.
Fig. 612.—Lordosis remedied by raising limb.
Fig. 613.—Disorganization of Hip-Joint. (From patient, Sarah B——, æt. 22, July, 1870. Excision of the joint was performed in this case, and a good result followed.)

passed into the bowel will often detect any swelling about the floor of the acetabulum. When dislocation is present, the symptoms will indicate its form.

All cases, however, of suppuration about the joint, even when associated with disease of the joint, are not to be regarded as a direct result of disorganization of the articulation, since it is quite certain that inflammatory mischief may exist in the joint and subside, and yet be followed by suppuration in the cellular tissue about the part; and in this opinion pathological does but confirm clinical observation. There may be some difficulty

in making out such cases during life, but I have no doubt as to their existence. In the hip they are the more common.

Prognosis.—When hip disease can be arrested in its early stage, a complete recovery may take place, more particularly when it has its origin in synovial inflammation, although when due to articular ostitis and the disease has been of long standing a recovery will probably ensue with anchylosis. When the joint has suppurated and a natural recovery follows, it must be, in the large majority of cases, with fibrous or soft anchylosis, and in the minority with bony. In the *Medical Times and Gazette* for 1869 I illustrated all these points fully by a series of cases.

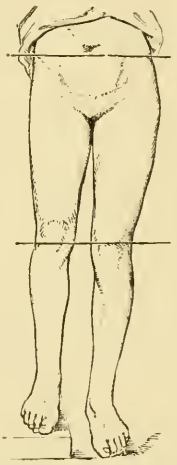
A very beautiful example of bony anchylosis is represented in Fig. 614.

It sometimes happens, when articular ostitis has attacked the head and neck of the femur in childhood and recovery has taken place with either a movable or an anchylosed joint, that some arrest of growth in the bone may be the result. I have seen this in a

Fig. 614.

Synostosis of Hip-Joint. (Taken by my father, the late Mr. T. E. Bryant, from a man æt. 42 who had had a stiff joint for thirty years. (Prep. 1318[48], Guy's Mus.)

Fig. 615.



Arrest of Growth in the Neck of Femur as a result of Articular Ostitis.

child who had been under my care when five years of age for articular ostitis, from which she perfectly recovered; the femur on the affected side at the age of eight was an inch shorter than its fellow, the trochanter nearer the median line of the body and the anterior superior spinous process of the ilium; the seat of the shortening was clearly in the neck of the femur, which had been arrested in its growth (Fig. 615).

Diagnosis.—The diagnosis of hip disease is to be made after a careful estimation of the value of the symptoms as a whole, and not upon one or more supposed typical symptoms. The limping of a child with infantile paralysis of the leg has been confused with that from disease of the hip, but the wasting of the limb and the absence of pain ought to prevent such an error. The pain of spinal disease, of psoas abscess, of sub-iliac abscess, of some glandular affection of the groin associated with limping, and nerve pain extending down the limb, may mislead, but the knowledge of these facts may prevent the repetition of such mistakes. A congenital displacement of the head of the femur has been frequently mistaken for the affection. (*Vide* p. 856.)

Disease of the bursa connected with the psoas muscle in front of the joint, which at times communicates with it, may render the diagnosis difficult, but the pain on pressure in front of the joint which exists in disease of the bursa, and the pain on pressure behind the trochanter in hip disease, are enough to distinguish the two. Disease of the bursa beneath the gluteus maximus muscle may also at times simulate hip affection, but with care the two affections can be distinguished.

Diseases of the Knee-Joint.

This joint is probably more frequently the seat of disease than any other, and in hospital practice my own statistics tell me that it forms forty per cent. of the joint cases admitted into Guy's. The greater liability of the knee to injury, the thinness of its

natural covering, and the complicated formation of the joint together probably afford the true explanation of this fact. It is met with, moreover, in patients of a more mature age than hip disease, sixty-two per cent. of hip cases and only thirty-two of knee disease being found in children under ten. It must be admitted, however, that the knee when once diseased is less likely to undergo a natural cure, and much less a cure by anchylosis, than any other articulation. This is probably to be explained anatomically by the existence of the inter-articular fibro-cartilages, which, while in a healthy joint they tend to keep it healthy, in a diseased, by forbidding the contact of the two bones, render it difficult for anchylosis to take place, since they must be at least partially got rid of by some suppuration or other change before anchylosis can be secured.

When diseased, there is no joint, however, in which the changes can be better recognized, or the clinical evidence of disease in the synovial membrane or bones be made out with greater facility.

In **synovitis,** acute, subacute, or chronic, the synovial sac becomes distended; the natural dimples or depressions which in health exist on either side of the patella soon disappear, and in their places a bulging of the synovial membrane will be both seen and felt (Fig. 616). The patella, too, becomes pressed forward, and on palpation may be felt to float as upon a water-bed, and readily made on pressure to dip upon the condyles of the femur which lie beneath. The extensor muscles above the patella likewise will be raised by the distended sac and the soft parts below the patella down to its ligament will project, distinct fluctuations being felt not only across the joint from side to side, but in an oblique direction from above downward.

Fig. 616.

Appearance of the Knee-Joint in Synovitis.

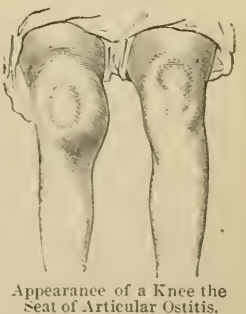
Acute synovitis of the knee, except as a part of so-called rheumatic fever or pyæmia, is rarely met with, unless as the result of a wound or the extension of suppurating disease into the cavity. It is a most severe affection, and unless speedily arrested by ice, leeching, or those means suggested in the chapter on wounds of joints, ends in the destruction of the joint, and too often in the forfeiture of the patient's life.

When, after suppuration, life is spared and the joint goes on to repair, anchylosis may be secured; and in puerperal, rheumatic, or pyæmic cases this result is not rarely met with, the joint undergoing the whole series of changes in a few months. This subject, however, will receive attention in the chapter on the suppuration of joints.

In *subacute synovitis*—a far more common form than the acute—the local symptoms are the same, but the constitutional are far less severe, whether the disease be caused by some local injury or by some general cause, such as gout, gonorrhœa, rheumatism, or syphilis; it moreover almost always terminates in recovery.

To *chronic synovitis* the same remarks are applicable. This affection is often known as "hydrops articuli," or simple dropsy of the joint, the chief symptom being an excess of fluid. In many of these cases, however, this effusion into the joint is associated with other changes, such as are known to exist in what is now recognized as a special affection—the *chronic rheumatic arthritis or osteo-arthritis.* In it the joint becomes so stretched by the effusion, and the ligaments at last become so useless, that the leg may be made to move about as a flail in every direction. In a large number, however, plates of bones will be found in the synovial membrane or about the articular ends of the bones, as well as bony outgrowths or fringes of ossific matter from the margins of the articular facets, together with other changes, to which attention will be directed in the proper place. It is well, however, to remember here that a large number of the cases of chronic synovitis or hydrops articuli are really examples of the peculiar disease known as rheumatic, or "osteo-arthritis."

Fig. 617.



Appearance of a Knee the Seat of Articular Ostitis.

In the **articular ostitis** of the knee-joint the expanded bones are soon made out on comparing the sound with the affected limb, for the articulation thus affected acquires a special shape which is not to be misinterpreted, the condyles of the femur and head of the tibia assuming a globular form, the soft parts covering in the bones being healthy and movable and no effusion existing in the joint (Fig. 617). At times a joint so affected will become two inches larger than its fellow; when effusion

is present, the extension of the inflammatory action from the bone to the joint itself is indicated, the case being clearly a more severe one.

The condyles of the femur or head of the tibia alone may also be the seat of suppurative disease, of an acute or chronic abscess, these local bone abscesses being probably more common in the head of the tibia than elsewhere. Under these circumstances the enlargement will be confined to the bone affected until the abscess burrows into the cavity of the joint, when the joint becomes inflamed. This suppuration may occur with or without necrosis. Fig. 634 illustrates a case in which diseased joint followed necrosis.

In the **pulpy disease** of the synovial membrane the local symptoms by which the affection is to be diagnosed are likewise characteristic. In typical cases neither expanded bones nor dilatation of the synovial sac with fluid is present, but the different points of bone which are always to be made out in a healthy joint are obscured, if not undistinguishable; they are covered in with a soft solid, yielding on palpation over the articular ends of the bones, and more particularly around the patella, a doughy sensation. No fluctuation is to be detected, as a rule; and when fluid exists, it will clearly be in a thickened capsule. At times this pulpy thickening of the synovial membrane is a secondary affection due either to some articular ostitis or to repeated attacks of synovitis. It may also occur as part of a syphilitic disease, from the effusion of gummy material around the joint. What Collis described as syphilitic joint I believe to be of this nature—viz., the pulpy disease in a syphilitic subject, possibly complicated with periosteal thickening.

Diseases of the Ankle-Joint.

Nothing particular is to be noticed in the diseases of this joint; their pathology is identical with that of all other joints, synovial mischief being possibly more common than affections of the bone. Effusion into the joint is readily detected by the swelling and consequent pressing forward of the extensor muscles of the foot, by the fluctuation between the malleoli in front, and at times behind, and along the borders of the tendo Achillis. Bone enlargement is readily seen by the expanded malleolus or malleoli. Bone abscess may occur in either malleolus or in the astragalus.

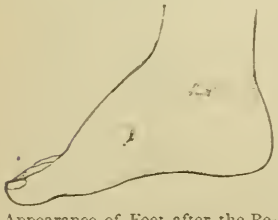
The pulpy disease makes itself known by some such swelling as is found in synovitis, but the swelling will not be due to fluid, but to the presence of the lowly-organized tissue found in the disease, showing itself in a doughy swelling around one or both of the malleoli and beneath the extensor tendons.

Disease of the Tarsal and Metatarsal Joints

—or, rather, of the bones and joints—is very common: for it is in the bones, as a rule, that the disease begins, the joints becoming involved secondarily. *Disease in the joint between the astragalus and os calcis may*, however, be found alone, and I believe that such disease is commonly the result of some lateral sprain of the ligaments that hold these bones together, lateral sprains of the foot being more likely to be felt at this articulation than at the ankle, as the astragalus is held so firmly between the malleoli. Disease in this joint is to be recognized by the swelling being *beneath* the malleoli, the pain produced by any lateral movement of the heel or foot, and occasionally by the grating of roughened bone. The movements of the ankle-joint will be uninvolved.

Disease of the other tarsal or metatarsal bones is indicated by the enlargement of the bones, as well as by the position of the sinuses leading down to them. The scaphoid bone and joints are frequently affected, this bone being the keystone of the antero-posterior arch of the foot; and when the scaphoid is affected, the disease very commonly extends to the cuneiform bones, there being but one synovial capsule common to the scaphoid and the three cuneiform bones.

Fig. 618.



Appearance of Foot after the Removal of the Scaphoid, Cuboid, and three Cuneiform Bones.

The form of the foot in these cases is very peculiar. "It assumes," writes Erichsen, "a remarkable bulbous or clubbed appearance: the fore part and dorsum of the foot are greatly swollen, glazed, and possibly perforated by sinuses discharging thin unhealthy pus" (*Science and Art of Surgery*). When necrosed, these four bones may be removed and a good foot left. As a single bone the cuboid is also not rarely diseased, and may be taken away without any detriment. In the case figured (Fig. 618) the scaphoid, three cuneiform, and cuboid bones were removed,

and an excellent foot remained. I removed them from a boy æt. 8 by simply enucleating the diseased and dead bones from their beds, and disturbing the periosteum and soft parts as little as possible.

Of the **metatarso-phalangeal joints,** that of the great toe is the one most frequently diseased, either from injury or otherwise; and when so affected, it is troublesome to deal with. There is some reason to believe that the bursæ about the sesamoid bones at the ball of the toe are occasionally the source of the evil.

When dead bone exists in these joints, it may be removed, and in some cases the joint may be excised with a good result. I have done this on many occasions, and in several a movable joint was secured. *Gouty* affections of this joint are very common, and may go on to disorganization. Disease of the joint as a result of a neglected bunion is not rare, but such cases will be treated of in another page.

Disease of the Pelvic Joints

is often overlooked or mistaken for hip or spinal disease, yet it has features of its own. It is more commonly met with in adults than in children, and after parturition than as a result of local injury. It is usually chronic. It may be secondary to disease of the bones that form the joint. In its early stage it is characterized by pelvic or gluteal pains which are aggravated by exercise, relieved by rest, and often put down as rheumatic. Lameness is generally present, with a very peculiar unsteady, rolling gait. Local tenderness will generally be manifested on digital pressure over the joint, and pain is excited by separating or pressing upon the iliac wings; swelling along the line of joint may also be visible. The thigh may or may not be flexed, but it will be made to move freely when the pelvis is fixed. As the disease progresses suppuration will appear either in the gluteal region over the sacro-iliac joint or in the pelvic; and when the thigh is permanently flexed, pelvic suppuration is indicated. It is to be distinguished from hip disease by the fact that there is free movement of the femur in the acetabulum when the patient is recumbent, and no spasm of pelvic muscles is experienced. There is, moreover, no swelling behind the trochanter or pain on pressure in the part. In no stage of the disease will there be any shortening of the limb.

Treatment.—In the treatment of this affection the same principles are applicable as in that of other joints, rest, tonics, good food and air being essentials. As soon as suppuration can be made out an incision should be made, to prevent burrowing; and when dead bone is present, it should be removed. I have taken away large pieces of bone from this joint with great benefit.

Disease of the simphysis pubis is very rare, and I have seen it but twice. One of the cases was in a man who some months before coming under my care was believed to have fractured his pelvis and lacerated his urethra. When I saw him, sinuses existed, running down to and into the joint, but no dead bone could be felt. In Guy's Museum there is a preparation (1314[50]) in which the synchondrosis is ossified and carious, and a second (1314[40]) in which complete anchylosis is present, with new bone.

Disease of the coccygeal joint is at least as rare as that of the pubic, although well-marked cases have been recorded. It can readily be made out by thickening over the joint and pain produced by any movement in the bone; in some cases a distinct grating can be felt with the finger in the rectum on attempting to move the part.

When the disease is clearly established and the joint disorganized, the best practice is probably the removal of the bone; and when this is not advisable or practicable, the coccygeal muscles had better be divided by a subcutaneous incision, to give rest to the joint, but under these circumstances the cure must be slow. The pains of sacro-coccygeal joint disease are much simulated by what Sir J. Simpson described (*Med. Times*, 1859) as coccydynia, which is met with in women when any of the coccygeal muscles are brought into action by walking, running, rising, defecating, or sneezing. This affection may be cured by the subcutaneous section of the coccygeal muscles.

Coccygeal anchylosis may occur between the sacro-coccygeal articulation or between any of the segments of the coccyx, or between all of them. The bones may retain their normal position or be so misplaced as to cause the point to be directed forward or backward, the former direction being more common.

When this forward condition is present, there may be some impediment to natural labor, but not of necessity, since Smellie (*Syd. Soc.*, vol. ii. p. 8) says, in the two cases he had seen, "the women were as easily delivered as those in whom the coccyx is mova-

ble." When difficulty is found, the bones should be fractured, the labor being aided by forceps if necessary.

Diseases of the Joints of the Upper Extremity.

Diseases of the Sterno-Clavicular Joint.—Suppuration of this joint in pyæmia is common, though as an independent disease it is very rare. I have seen but two examples of it, which ended in disorganization. In syphilitic subjects, however, inflammation about the joint is not unfrequent, but such cases rarely suppurate. The disease, when it occurs, is easily recognized, the joint being superficial.

Disease between the sternal segments has been recorded by Hilton. I have seen but two examples of it, and both were complicated with substernal abscess and necrosis. Local pain, increased on pressure, and the movement produced on coughing, with swelling, indicate the disease.

Diseases of the shoulder-joint are comparatively rare and form a very small proportion of the joint cases admitted into a hospital, the majority of such cases being treated outside. Synovitis, however, in all its forms, is found in this joint, as well as cases of articular ostitis, etc. The joint has no special disease.

When disorganization and suppuration take place, the matter burrows down the bicipital groove and generally makes its appearance in front of the insertion of the deltoid muscle; at times, however, it bursts posteriorly or burrows beneath the pectoral muscle.

If recovery take place with anchylosis, a wonderfully useful limb is often secured, the scapula allowing an amount of movement which is sufficient for most of the duties of life, though it rarely admits of any action above the shoulder. When disease takes place at the junction of the upper epiphysis and shaft and suppuration follows, the abscess burrows in the same way, and much difficulty may be experienced in the diagnosis of the case, although the thickening about the neck of bone under these circumstances is generally greater than in joint trouble. When inflammation of the bursa placed beneath the deltoid muscles exists, some of the symptoms of shoulder-joint disease are present; but the fact that the least action of the deltoid muscle excites pain in bursal disease when the movement of the arm by the surgeon does not, and that the joint moves freely, although possibly attended with a sense of crepitation, ought to suggest its nature.

Diseases of the elbow-joint are of great importance, as the value of the hand is greatly dependent upon the integrity of the elbow, and a stiff elbow-joint is a serious detriment. In their general pathology they are the same as similar diseases in any other joint.

Synovitis makes itself known by the general enlargement of the joint, as well as by the sense of fluctuation on either side of the olecranon process. Pulpy disease is recognized by the presence of the doughy, semi-fluctuating products that have been poured out in the same position. Articular ostitis can be recognized by the expanded bones.

In a general way elbow-joint cases do well, recovery taking place with movement in the majority, while in the minority a natural cure takes place by anchylosis, with or without external suppuration.

The amount of movement that may at times be secured after a natural recovery from a suppurating joint is very good. Fig. 619 was taken from a boy æt. 19 who had had a disorganized joint treated by free incisions when ten years of age. In it the head of the radius was displaced outward. He had as much movement as the drawing indicates. In many cases useful flexion and extension are often secured, as well as pronation and supination, and in some, while these latter movements are preserved, the ulna and humerus are firmly fixed together; and when so, the value of the hand is but little diminished. In several of my own cases I have found the rotation of the radius perfect after many years.

Fig. 619.

Drawing illustrating the Amount of Flexion after Recovery from Suppuration.

But as these good results, which may follow a cure by natural processes, cannot be calculated upon, it is doubtless a wiser course to submit the majority of cases of disorganized elbow-joint to operative interference—not so much, probably, to remove a disease that is incurable by natural processes as to procure movement and prevent anchylosis.

Disease of the wrist-joint is not so common as that of the carpal bones and

carpo-phalangeal joints; but when it has started in one of those parts, it is very prone to be propagated to others. When suppuration takes place, the pus often burrows freely between the tendons, but as long as necrosed bone does not exist to prevent recovery a good result may be looked for, although probably with some amount of stiffness or even anchylosis. When necrosed bone keeps up the irritation, it should be removed. To assist recovery the hand should be secured by a splint in the position intermediate between pronation and supination, such a one being the best. When the hand is left alone, it is too apt to assume the prone position—a by no means good one.

Disease of the radio-ulnar joint is rarely met with. In a recent case of a middle-aged man that came under my care it appeared to follow overaction and gave rise to severe local pain and general disturbance. It was followed by suppuration and relieved by a free incision on the dorsal aspect of the wrist down to the joint. The case terminated by anchylosis.

Diseases of the phalangeal joints are in their nature like those of other joints and must be dealt with upon similar principles, synovitis, pulpy disease, and bone disease, with or without disorganization, being found in all. When the disease is confined to the synovial membrane and the joint has not disorganized, a recovery with movement may be secured by good treatment. When a natural cure by anchylosis only can be looked for, the question of the removal of the finger may be entertained as a matter of expediency; for a stiff metacarpo-phalangeal joint is a serious detriment, while at the proximal phalangeal joint anchylosis is less injurious, and least so at the terminal one.

In the thumb amputation is rarely to be thought of; for when recovery by anchylosis from disease of the distal phalangeal joint is probable, a good thumb may be secured, though the same result in the metacarpo-phalangeal joint is so inconvenient that the operation of excision is probably preferable. But every case must be treated on its own merits and according to its own special wants.

The position of the patient, his occupation, age, etc., should have a powerful influence in guiding the surgeon to a decision.

ON THE TREATMENT AND CURE OF JOINT DISEASE.

In the treatment of joint disease the most important point a surgeon has to bear in mind is its curability, since clinical experience affords convincing evidence that under judicious management a large proportion of joint cases can be guided successfully to a complete recovery with either movement of the joint or anchylosis. It is in exceptional cases only that operative interference is required.

The recollection of these facts is a constant encouragement to the surgeon to persevere with, and to the patient to submit to, the necessary means adapted to secure either of these ends, while it in no way tends to discourage operative interference when the course or the severity of the disease affords sufficient evidence that surgical interference is expedient or necessary.

All pathological evidence likewise tends to the support of these conclusions, for no one can have carefully examined joints that have been treated by either excision or amputation, or others that have failed to go on toward a successful issue, without being struck by the vast amount of repair that exists side by side with the disease and by the apparently limited character of the latter, and also without feeling that in many cases where a capital operation had been performed simpler operative interference would probably have been successful, or that none at all was really required.

At the same time, it must be borne in mind that while in a pathological sense disease, on account of its limited nature or reparable character, may need no interference, yet in a clinical aspect a very opposite conclusion may reasonably have to be drawn, since the disease, by its progressive and weakening tendency, may have demonstrated that the powers of the patient were incompetent to provide, even in limited disease, the stimulus needed for repair.

In the treatment of joint disease, however, it is not always a question as to the possibility or the impossibility of securing a successful issue by simply aiding natural efforts, since questions of expediency come before the surgeon as to the wisdom of making the attempt or as to whether better results might not be secured by surgical interference.

Surgeons, moreover, who look upon a stiff elbow- or shoulder-joint as a serious inconvenience and an unsatisfactory result of treatment, consequently advocate early excision of a joint with the view of obtaining movement, and those who have little belief in natural processes guided by art bringing about anchylosis in disease of the knee, or who

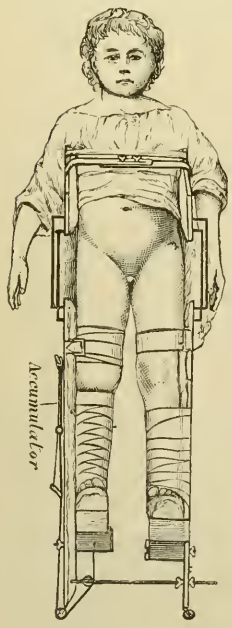
think that the time occupied in the attempt is badly spent, advocate a like practice. While some surgeons are always satisfied with a cure of the disease by natural efforts assisted by art, and remove by operative measures joints or parts of joints when these natural processes have proved themselves incompetent to effect a cure, others maintain that in a large number of cases these natural processes lead only to an undesirable end, and that it is not expedient to trust to them. Arguments of expediency also are used, and in recent times have gained in importance, more particularly as brought to bear upon the question of a cure with a stiff joint when a prolonged interval of time must of necessity be required to secure the end. In some cases such arguments are of weight and worthy of consideration, although as a broad rule of practice it is dangerous to adopt them, for in the majority of cases natural processes guided by art are followed by results which leave little to be desired, and are secured without the risks which are attached to all operative interference. These points, however, will come out better when the treatment of individual joints has to be considered, and to which attention will now be drawn.

Treatment of Disease of the Hip-Joint.

The average total duration of a case of hip disease in which recovery takes place *without* external suppuration is three years, and *with* suppuration four.

So long as suppuration or other disorganizing change in the joint has not appeared a good hope of a recovery with a useful articulation may be entertained, and so long as the disease is in the synovial membrane the probabilities of a recovery with a movable joint are great. In a large number of cases where time has been allowed to pass and disease has gone on to produce degenerative changes in the articular cartilages recovery with anchylosis is to be looked for, anchylosis without suppuration being more common after articular ostitis than after synovial disease (*vide* paper by author in *Med. Times*, July and August, 1869). When, however, disease originates in the epiphysis of the head of the bone or in the epiphysial connective cartilage between the epiphysis and shaft, the prospects of a recovery with movement are slight unless the mischief be checked in its early stage; for in the former case the articular cartilage which derives its nourishment mainly from the bone soon undergoes degenerative changes that can be repaired only by processes ending in anchylosis, and in the latter the epiphysis is often cast off as a foreign body when recovery can take place only on its exfoliation or removal.

Fig. 620.



Double Splint with Elastic Extension, as applied in Disease of the Right Hip-Joint.

In both classes of cases, however, the treatment is in a measure the same—that is, the joint is to be at rest and all inter-articular pressure is to be avoided, for "in diseases of the joints *rest* cannot be too much insisted upon" (John Hunter, 1787); and for these ends the application of a splint is essential, that form of splint being the best which keeps the joint quiet, the pelvis at its normal angle to the spinal column, and the affected limb from being either adducted or abducted; without doubt these points are best preserved by the double splint figured in 573, 620. Children, with this splint well adjusted, can be moved with the greatest facility and, even when there is acute joint disease, with very little suffering. When the acute symptoms have subsided and the disease is clearly going on to repair, Thomas's splint is good. (*Vide* Fig. 621.)

Fig. 621.

Thomas's Posterior Splint as applied for Hip Disease.

The **hip splint** consists of a long piece of malleable iron, one inch by a quarter for an adult and three-quarters of an inch by three-sixteenths for children, extending from the lower angle of the shoulder-blade to the centre of the calf of the leg, to which an iron oval chest hoop measuring four inches less than the chest circumference is firmly riveted at the upper end, and two half hoops to support the thigh and calf, as seen in Fig. 621.

The vertical iron band is carefully modelled to the outline of the trunk and limb and the chest hoop fitted to the sound side, but away from the diseased. The whole should be well padded and bound to the body, passing in the direction of the sound side over the posterior surface; and if this is efficiently done, the diseased limb will be well supported, and the patient, if a child, can readily be moved from room to room.

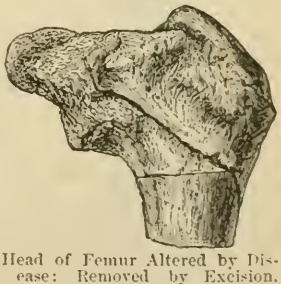
The curve of the instrument may require alteration from time to time as the flexed limb becomes extended and the curved spine straight.

Sir C. Bell clearly saw the necessity of rest, and was so impressed with it as to make the following ingenious suggestion: "I have observed that patients who have hip disease recover when anchylosis of the joint takes place, when the bones become fixed and immovable. Founding upon this, I attempted by various contrivances to form an instrument which might keep the bones at perfect rest, but so great is the tendency in this joint to motion that I have never yet succeeded. No instrument has ever been effectual in keeping the thigh and trunk fixed." "I have been led to think that an operation might be performed here; *that a cut might be made to expose the upper part of the femur* and the *neck be sawn through*—not, you will observe, to take away the head of the bone, as done by Mr. White with success, *but to permit it to remain at rest* and to form an adhesion with the acetabulum. In this case a joint will be formed where the bone has been divided" (*Lond. Med. Gaz.*, January 12, 1828: "Hip Diseases," by Sir C. [then Mr.] Bell).

When **suppuration has appeared,** recovery with anchylosis can alone be looked for, though where diseased bone exists this result cannot be expected unless the diseased bone is cast off or removed. When, however, an abscess has been the result of chronic changes in a pulpy synovial membrane, the complete disorganization of the joint need not as a necessary consequence be contemplated, although where it has followed disease in the articular extremities of the bones (articular ostitis) it is more than probable that the articular cartilages, with the ligaments and synovial capsule, will have been completely destroyed. Under the former circumstances, therefore, when the suppuration has taken place as a consequence of synovial disease, recovery may ensue with soft or fibrous anchylosis, or even with some degree of movement, whilst under the latter, though fibrous anchylosis may supervene, osseous anchylosis can occur only after the cartilages with the articular lamellæ of bone have entirely gone and there is no necrosed bone left to keep up the disease: for with this complication a natural recovery cannot take place till the source of irritation has been discharged by natural processes or removed by art.

When suppuration occurs in a hip-joint, though recovery may follow with partial movement, there is but one result a surgeon can reasonably look for and strive to secure, and this is anchylosis. If the history of the case and the clinical symptoms indicate that the disease began in the synovial membrane and that the suppuration was the result of pathological changes in that tissue alone, the hope of securing this result is very good, since the disease in the joint, however extreme it may be, under these circumstances is probably only superficial and does not involve the bones to any extent, so that a good recovery with a stiff joint may fairly be anticipated. If, however, the history of the case and the clinical symptoms indicate disease of the bones, the probabilities of the same result taking place will rest upon the amount of the disease. If the disease in the bone be superficial, a natural cure by anchylosis may be looked for, since dead bone, if not too large, and even the epiphysis, may be discharged externally and a good recovery follow. When, however, disease in the bone is extensive (Fig. 622), or a sequestrum is so placed in the centre of the bone as to keep up irritation and interfere with repair, as is shown in Fig. 601, the surgeon's active interference will be imperatively demanded; and it may be added that it is never practised with better results.

Fig. 622.

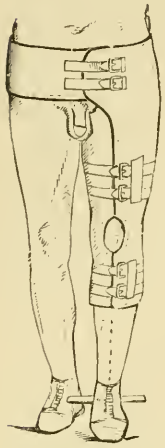


Head of Femur Altered by Disease: Removed by Excision. (Prep. 1318[39].)

Under all circumstances, however, the first point in treatment is to secure the complete immobility of the limb, which can be ensured by splints: extension should likewise be kept up by means of weights or elastic forces. In one case a long outside splint may be enough, while in another the weight is sufficient. In very chronic cases an immovable casing of leather, gutta-percha, felt, wire, perforated zinc, or other appliance, such as the fancy or ingenuity of the surgeon suggests, is the best. absolute immobility of the joint, prevention of inter-articular pressure, tonic treatment, liberal regimen, good air, and time being essential conditions for a successful issue. Fig. 623 represents a good apparatus to ensure immobility when the patient is in bed, though the double splint figured 620 is

better, for with it pressure over the trochanter is guarded against, abduction and adduction of the affected limb are prevented, the pelvis is fixed at a right angle to the spinal column, and the external malleolus of the affected side is kept in a line with the hip: elastic extension is likewise well maintained by means of an accumulator acting through a cord working over a pulley inserted in the cross foot-piece. Mr. C. de Morgan's long splint (Fig. 581) is also good applied to the side of the sound limb, through which he likewise applied all counter-extension.

Fig. 623.



Immovable Casing of Hip Disease.

When malposition such as arises from flexion, abduction, or adduction of the thigh exists—a position which would be detrimental to the patient's welfare—it is essential that it should be remedied before the plan of treatment already laid down is carried out; and so long as no anchylosis has taken place or the union is soft there is a good prospect of this being effected. For this purpose an anæsthetic should be given and the thigh slowly but surely brought to a straight line with the body and there fixed, any inflammation caused thereby being checked by the local application of cold. At times, however, active disorganizing changes and bad results follow. When displacement or dislocation of the joint exists, it is often in the surgeon's power to reduce the dislocation, and then to treat the case as one of the ordinary kind. In the case from which Fig. 624 was taken the boy was eleven years old; the disease had been acute, and the dislocation was on the ilium. Its reduction was readily effected under chloroform, and a good result followed. A weight of six or seven pounds was enough to keep the limb in position, and the counter-extension was well applied on the opposite side of the pelvis. If, however, I had now the treatment of this case, I should employ the double splint with elastic extension.

When the displacement is of long standing and the natural cure of the disease has gone on to its end, it is not wise to interfere and thus run the risk of undoing what nature has well done, as many of these cases of supposed dislocations are not of this kind, but simply a shortening of the neck of the bone from the absorption or destruction of the head or epiphysis of the femur, or at times of the acetabulum. Drs. March and Sayre of New York deny the existence of a dislocation, but in this they are wrong. It

Fig 624.

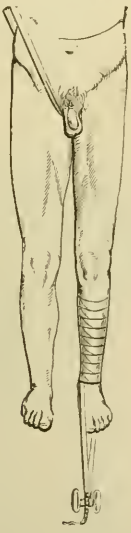
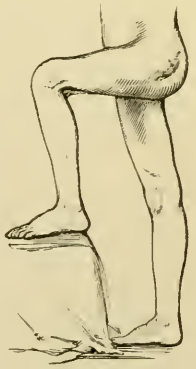


Fig. 625.



Anchylosis of Hip-Joint, with Femur at Right Angles to Pelvis, before Operation. (Case of Boy æt. 15.)

Fig. 626.

Position of Limb after Adams's Operation as Performed by Author.

does occur, although rarely. In the case from which Fig. 624 was taken it was very clear.

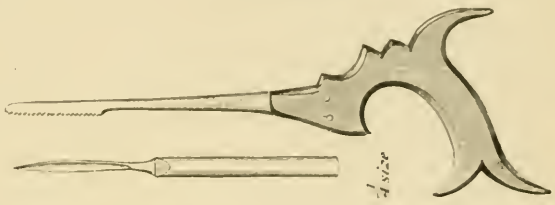
In exceptional instances the displacement of the limb is due to a separation of the neck of the bone from the epiphysis, which is left fixed in the acetabulum or is cast off. This condition is illustrated in Figs. 607, 608.

When anchylosis has taken place at a bad angle—at such an angle as seen in Fig. 625—any attempt at forcible flexion with the view of breaking down the adhesions must be

looked upon as futile and unjustifiable, although it may be right to consider the propriety of improving the position of the limb by some surgical procedure; and for this object several surgical operations have been devised. Thus, in 1875, M. Tillaux presented before the Surgical Society of Paris a woman æt. 32 the subject of bony anchylosis of the hip-joint, with the limb flexed and rotated inward, for whom he had with success *forcibly fractured the neck of the bone*. He effected this when the woman was under chloroform by using considerable force, the bone giving way with a loud crack. He subsequently treated the case as one of fracture, and at the end of two months the patient had a straight limb. M. Tillaux described the result as *splendid*, and considered the practice infinitely preferable to the operation of subcutaneous section of the neck of the bone. The operation is doubtless of value in certain cases and worthy of consideration.

In 1869, Mr. W. Adams (*Brit. Med. Journal*, 1870) successfully treated a case of this nature by subcutaneous division of the neck of the thigh-bone by means of a fine saw, and since then many operations of the kind have been performed with good success.

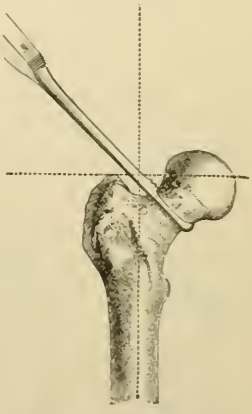
FIG. 627.



I have performed this operation in a dozen cases, and with so much success that I believe it to be the best when the femur has a neck to be divided.

The instruments required for the operation are such as those figured (Fig. 627). The operation itself I give in Mr. Adams's words: "I entered the tenotomy knife a little above the top of the great trochanter, and, carrying it straight down to the neck of the thigh-bone, divided the muscles and opened the capsular ligament freely. Withdrawing the knife, I carried the small saw along the track made—pursuing this by pressure of the fingers—straight down to the bone, and sawed through it from before backward, in the direction represented in Fig. 628, which shows the saw applied to the anterior surface of the neck of the bone. The section of the bone was accomplished in four minutes. No hemorrhage followed, and a good recovery took place with a stiff limb." When the saw is used, it should be held at an angle of 135° to the line of the shaft of the femur (Fig. 628). Some surgeons use a narrow chisel, but I prefer the saw.

FIG. 628.



Drawing showing the Line of Section of the Neck of the Thigh-Bone in Adams's Operation.

In my cases the neck of the thigh-bone was readily divided in less than five minutes and the wound above the trochanter healed in a few days, the patients walking in eight weeks. I have had one patient, a girl æt. 11, in whom both hips were anchylosed in a flexed position against the abdomen, one being adducted and the other rotated outward. On one side I divided the neck of the femur and on the other the shaft below the trochanters, and with such a good result that the patient can now, six months after the second operation, walk by the aid of a stick and sit with comfort.

I did not attempt to obtain movement in any of my cases, having been well satisfied with the results secured, although I am quite alive to the fact that my friend Mr. Lund of Manchester had operated with such success upon a man who had both hip-joints anchylosed in a straight line with the body, and as a consequence could not sit, that after the operation excellent motion was obtained in each hip-joint, and the man could sit up in a chair with the body nearly perpendicular and the thighs comfortably placed on the seat; he could moreover support the weight of the body upon the legs (*Brit. Med. Journ.*, January 29, 1876).

When there is no neck of the femur to be divided, or when the muscles and soft parts about the minor trochanter of the bone are so contracted and rigid as to render it probable that the shaft of the femur cannot be brought down to a right line, Gant's operation (*Lancet*, December 1, 1872) should be performed—that is, the femur should be divided by a small valvular wound subcutaneously below the trochanter, by means of either the saw, as employed by Adams, or the chisel, as suggested by Volckmann and advocated by Maunder, the same care to exclude air being employed in the operation as has been

advised in Adams's. Both these operations are superior to that of Barton, who divided the femur between the trochanters, and to that of Sayre, who excised a wedge of bone from between them.

Treatment of Diseases of the Knee-Joint.

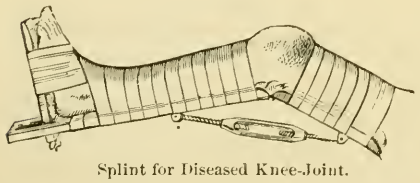
This may be taken as a type of the treatment of all joint diseases.

Acute synovitis is usually the result of a wound and should be treated according to the principles laid down in a former page—viz., by rest and ice locally and opium internally. When disorganization of the joint ensues, free incision and irrigation are called for; few cases are more serious in their local as well as their general effects, as life is often endangered, and recovery with a stiff joint must be regarded as favorable. When the disease is the result of septicæmia or rupture of an abscess into the joint, no better success can be expected.

In **subacute** and **chronic forms of synovitis** a good result may, as a rule, be promised, and the treatment must be regulated by the cause of the disease. In traumatic cases the local application of cold or warmth according to the amount of comfort one or other affords, and immobility by means of splints, are the best means to use. When all inflammation has subsided and a relaxed condition of joint remains, gentle support by means of well-applied strapping is a valuable adjuvant.

In other cases the application of a blister to either side of the joint, as well as the internal administration of the iodide of potassium, with or without bark or quinine, according to the necessities of the patient, is of great use. When gout appears to be an element in the affection, it is advisable to administer colchicum, lithia, and other remedies approved in that disease. When the case appears to have a rheumatic origin, alkalies such as the bicarbonate or citrate of potash, etc., may prove serviceable; and when there is any reason to suspect syphilitic taint in the constitution, it is necessary to employ such treatment as is peculiar to such diseases—viz., the iodide of potassium or sodium, or some mercurial.

Fig. 629.



Splint for Diseased Knee-Joint.

In very chronic and obstinate cases paracentesis of the joint by means of the *aspirator* may be performed, and in the hands of some has yielded marvellous success. Sir J. Fayrer was one of its strongest advocates, having shown (*Indian Med. Gaz.*, 1869) that in the chronic and subacute forms much good is often obtained by the operation if care be taken to exclude the air by carefully closing the puncture and fixing the joint on a splint, the drawing off of the fluid affording instantaneous relief. I have performed this operation on many occasions with good results when the tension of the joint was extreme; it is a practice, however, that ought to be followed with great caution.

Fig. 630.

Thomas's Knee-Splint.

Fig. 631.

Knee-Splint as Applied to Left Limb, with Patten on Right.

The pulpy disease of the synovial membrane is a very obstinate affection, and, though fairly curable with a movable joint in its early stage, and occasionally so in a later, is always tedious and unsatisfactory.

In its treatment the absolute immobility of the joint is most essential. This may be guaranteed by the application of a well-adapted splint (Fig. 629) reaching from the foot two thirds up the thigh, or, what is far better, Thomas's knee-splint (Fig. 630), composed of a padded ovoid iron ring, three-eighths of an inch thick, to fit well up in the groin, and two vertical iron rods, ending in a patten about four inches below the foot, with an intermediate foot-piece (Figs. 630, 631). An apron of basil leather is stretched between the iron bars for the affected limb to rest upon, in which slits are made for the insertion of a bandage to keep the limb and splint together. When the patient gets up, the splint is suspended by a strap buckled to the ovoid thigh-ring and passed over the shoulder of the sound side; and when he walks upon the splint, a patten has to be fitted to the foot of the opposite limb, to maintain the level of the body (Fig. 631).

When the knee is much flexed, a cushion or pad should be placed behind the knee, which unfolds itself by a gradual process of extension.

As the disease improves and the dependent position of the limb becomes allowable the patient can get about by means of a patten on the opposite limb. The introduction of this patten for the above purposes is worthy of all praise.

Fig. 632.

Bavarian Splint as completed for Disease of the Knee.

As long as any heat or periodic flushing of the joint exists the limb must be kept raised and warm moist applications applied by strips of lint surrounding the joint. After these symptoms have subsided and the products of inflammation alone remain, well-applied pressure by means of strapping is of great value. Mr. Marshall (*Lancet*, May 25, 1872) speaks highly of the five per cent. solution of the oleate of mercury in oleic acid as an application, and my experience of its use has been satisfactory. Blistering and firing in this affection seem to be of little value. In the very chronic stage of the disease the Bavarian flannel splint (Figs. 536, 632) or some other good casing may be employed.

The constitutional treatment in all stages of this affection is essentially tonic, as the subjects of it are always feeble and often strumous; iron, quinine, bark, cod-liver oil, good food, and fresh or sea air are essential elements of successful treatment.

By these means, so long as suppuration has not set in, a cure may be affected, although many months may be required for its attainment.

When suppuration appears, the same principles of practice are applicable. When small deposits of pus form, from the breaking down of some portion of the pulpy tissues, and make their way externally toward the skin, and not into the joint, they may be evacuated, and a good result still ensue. But when the joint becomes disorganized from the same cause, questions arise as to the expedieney or possibility of saving the joint: but this subject will claim attention in the chapter on suppurating joints.

In **articular ostitis**—a disease readily made out in the knee when simple expansion of the bones (Fig. 617) and an aching pain and heat are the local symptoms—all walking or standing should be positively interdicted, everything like inter-articular pressure forbidden, and fomentations of warm water applied two or three times a day, or strips of wet bandage covered by a handkerchief of elastic tissue or oil silk kept around the joint. Some speak highly of blisters, moxas, and counter-irritants, which I rarely employ, having long found the above practice preferable.

When heat has left the joint, the aching—miscalled "growing"—pains disappear, and clinical evidence tends to show that all inflammatory action has subsided, the results or products of inflammation alone remaining, local pressure as applied by strapping not only gives comfort to the patient, but appears to help the absorption of the inflammatory products and the subsequent cure of the disease.

Constitutional treatment, however, must not be forgotten, and tonics, as a rule, are needed, cod-liver oil combined with the syrup of the phosphate or iodide of iron being a suitable prescription for children. When the appetite is bad, quinine may be given; at other times, iron or other tonic. Good food and good air are as necessary in this as in all other joint cases. The use of the iodine-evaporating box should not be omitted. Mercury is unnecessary.

In the early stage of articular ostitis splints are not required, as the joint is not itself diseased and passive movement of the articulation will not do harm; all inter-articular pressure, however, should be avoided, and for this purpose extension by means of weights or elastic extension is very valuable. In a more advanced stage, however, when the disease has so progressed in the bones as to have set up some degenerating process in the cartilages and the synovial membrane has become involved, as indicated by effusion or the pulpy synovial thickening, the use of the splint is essential.

In neglected cases, when the joint has been allowed to assume an abnormal position—the most common being that of flexion, with some amount of rotation inward or outward—and in still worse cases, where dislocation of the tibia and fibula backward has taken place, the deformity must, if possible, be remedied by gradual extension. This should be employed by means of a posterior screw splint or the application of a constant gentle force exerted through one of the many instruments that have been made with the view of pressing the femur backward and the head of the tibia forward. Manual extension exerted under chloroform employed with care rarely does much harm; forcible and sudden extension cannot be recommended, as it is followed at times by severe local action and suppuration. In exceptional cases it may be required.

Anchylosis.—When a knee-joint has to be fixed, the best position is one of slight flexion, or that which a man naturally assumes when he stands at ease. But anchylosis is more difficult to secure in the knee- than in any other joint, on account of the presence of the inter-articular fibro-cartilages, which prevent the bony surfaces from coming in contact. Moreover, these cartilages, when diseased, are most difficult of repair, no tissue undergoing a reparative process more slowly or imperfectly. It is doubtless from a knowledge of these clinical truths that some surgeons despair of securing anchylosis in the knee, and even doubt its occurrence, and are led to interfere by operation oftener than others. Anchylosis of the knee—good solid ossific union of the bones as well as fibrous anchylosis—does, however, occur, and when secured is of great value. It gives a limb which is far superior to any that follows excision, and is, as a rule, obtained without the dangers of an operation, although possibly with the expenditure of more time. I have the notes of many such cases, and in the *Med. Times* (1870) I published a series, in some of which this result took place with and in others without suppuration.

Diseases of the Ankle-Joint

should be treated on precisely the same principles as those laid down for the knee, the best position of the foot being at an angle slightly exceeding that of a right angle.

Diseases of the Shoulder-Joint,

in their progress and treatment, are very similar to those of other joints. When the shoulder has to be fixed, a leather casing including the scapula and humerus is a good apparatus, the elbow being supported at the same time. The arm should be allowed to hang parallel to the trunk, with the elbow slightly away from the chest; and for this purpose Stromeyer's cushion is of great value (Fig. 561).

Diseases of the Elbow-Joint

can usually be managed with greater ease than any other, a splint applied in the flexure of the joint passing well down to the hand, to keep the radius in a position intermediate between pronation and supination, being the best. If the hand is left unsupported, it is certain to assume the prone position, which, as a rule, is undesirable. Dislocation of this joint, except at the head of the radius, which is often displaced backward and somewhat outward, rarely takes place as a result of disease.

Before fixing the joint at an angle it is well in most cases to consult with the patient, for in some the straight position is the more desirable. In the case of a painter I had under care a flexed elbow would have lost him his occupation. In another, of a bargeman, the joint was fixed at a right angle, with the hand pronated, to hold the oar. A carpenter asked me to fix his left elbow at an obtuse angle, and a haycutter nearly straight. In all these instances any other position would have been most detrimental.

In disease of the **wrist** and **carpus** the same position of the hand should be maintained as in disease about the elbow.

In disease of the **phalangeal joints,** when anchylosis is to be obtained, I have of late years always fixed the diseased extremity at such an angle as will allow its point to come in contact with the top of the thumb, having invariably found the straight positions of the finger very inconvenient. In this position the fingers are more useful and less in the way, and the deformity is less observed. In these cases the best material to use as a splint is a piece of zinc or tin, which is firm, thin, and takes up little space.

ON OPERATIVE INTERFERENCE—EXCISION AND AMPUTATION—IN JOINT DISEASE.

General Remarks.

In the treatment of joint disease, next to the preservation of life, the aim of the surgeon is to preserve the natural movements of the articulation, and, when that hope has gone, to save the limb. If this end can be obtained with a stiff joint, the result in disease of the lower extremity may be regarded as satisfactory, and even in the upper a stiff shoulder- or elbow-joint at a useful angle is not so bad a result as some would endeavor to lead us to believe.

When neither of these ends appears probable, possible, or expedient from the extent of the local disease, the general want of power of the patient, or the necessities of the individual case, the question of operative interference comes before the surgeon, and he has to decide on the expediency of an incision into the joint, the removal of dead bone from or excision of the joint, or amputation; and to work out the many points involved in the solution of these questions is a task of difficulty, since, from joints having a different value in the human body, a form of practice which is applicable to one may be inexpedient to another. This difficulty, moreover, is doubtless aggravated by the different value which surgeons place on different forms of practice and the different estimation in which they regard natural processes. One who has great faith in natural processes in the cure of disease, and particularly of joint disease, will attempt to save a limb that another will condemn, since he regards as wrong any practice that interferes with a natural recovery so long as any reasonable hope exists of securing such a result, and believes that a cure by anchylosis, however acquired and however long a time may be passed in securing it, is worth the attempt. Another, who has stronger faith in surgical treatment, will excise a joint, believing it to be inexpedient to attempt to obtain a natural cure, even if it may be gained, when by excision an equally good, if not a better, result can be secured in a shorter time; and a third, looking upon both forms of practice as too protracted and uncertain, will remove the diseased parts by amputation, under the conviction that a more certain as well as a more rapid recovery will be secured by such a process.

To lay down any definite rules upon operative interference in joint disease generally is consequently an impossibility, since each joint has its own surgery.

It may, however, be stated as a starting-point that no surgical operative interference is justifiable unless a joint has suppurated or become disorganized, and that amputation should be thought of only when all minor measures are inapplicable and it is necessary to remove the disease to save life. The larger the joint, the greater the dangers of operative interference.

Treatment of Suppuration of the Hip-Joint.

In the treatment of a suppurating hip-, as of any other joint, it is important to ensure a free vent for all discharge, as pent-up pus is always injurious; with this view a free incision into an abscess connected with the hip or the free opening of a sinus through which pus slowly flows is sound practice. In the residual abscesses of repairing joint disease it is well, however, not to incise unless they show a tendency to increase, since many often spontaneously dry up. When these abscesses are interfered with, the pus should be drawn off with the aspirator.

Removal of Necrosed Bone from and Excision of the Hip-Joint.

When the presence of dead bone can be made out in a suppurating hip-joint, there can be no question about the propriety—nay, the necessity—for its removal, since it is certain that so long as dead bone remains to keep up irritation a cure by natural processes is impossible. If this can be effected by means of a free incision, nothing more is needed; when the os innominatum is involved, there is a greater reason in favor of the removal of the sequestrum. An operation undertaken upon the hip-joint under these circumstances is scarcely more dangerous than any severe operation for necrosed bone, and in all probability is less so. The joint, as a joint, has to a certainty disappeared altogether, and a free incision into it will hardly add to the dangers of the case. In a large number of cases, however, this cannot be made, and under such circumstances, when a cure by natural processes cannot be looked for, the best practice lies in excision of the head of the femur: and if the acetabulum is superficially affected or stripped of its cartilage (the disease being probably secondary to that in the femur), it will undergo a natural repair as soon as the cause of its disease has been removed.

When the presence of dead bone cannot be made out, or the weight of evidence tends to show that there is no such complication to interfere with a natural recovery, the question of excision of the head and neck of the femur may have to be considered. Those who argue against its adoption assert, and with some truth, that while all these cases of hip disease are capable of a natural repair in patients who have good, or even tolerably good, reparative powers, yet in those who have not the operation of excision must naturally fail, since as much power is probably needed to effect a cure after excision as is demanded for the natural repair of an uncomplicated suppurating or disorganized joint.

To these latter remarks, however, I am disposed to demur; and while ready to admit that in all cases of disorganized hip-joint in which there is no disease of the bone to interfere with recovery a natural cure may be fairly looked for so long as the powers of the patient keep up and no signs of failure make their appearance, yet when these signs show themselves, or evidence is adduced that in the battle of disease the reparative are weaker than the morbid processes, and treatment fails to turn the scale in their favor, the expediency of performing excision cannot be disputed. The removal of the source of irritation acts beneficially upon the patient, and after the operation of excision many a case has gone on to recovery which unoperated upon would eventually have proved fatal, the patient being worn out by suppuration and exhaustive efforts to repair.

For the most reliable facts connected with the operation of excision of the hip-joint, I must refer to the report of the committee of the London Clinical Society published in the fourteenth volume of their *Transactions* (1881). In it, amongst much valuable material, are certain conclusions based upon a careful analysis of 203 cases of excision, of 260 other cases in which suppuration existed, and of 124 in which no such complications appeared, making a total of 587 cases. Where excision was performed the mortality was 40 per cent., against 33.5 per cent. treated by rest and extension, etc. A large proportion of the deaths in both classes was from tubercular meningitis. I have lost but 5 out of 30 cases operated upon, and, although I cannot say that in the 25 surviving all had useful limbs, I am within the truth when I assert that the majority had, while without the operation recovery was impossible.

Mr. Holmes, too, in his excellent work on *Children's Diseases*, gives us 19 cases, of which, in a general way, one-third died from the operation, another third recovered with useful limbs, and the remaining third, although not cured, derived great benefit from the operation.

On analyzing Hodges' and Good's cases as to the influence of age upon the operation, some valuable facts may be recorded; and out of 46 of Hodges' cases operated upon under ten years of age, 15 died, or 33 per cent.; of 37 cases between eleven and twenty years of age, 21 died, or 57 per cent.; of 12 cases operated upon between twenty-one and thirty years of age, 7 died, or 60 per cent.; and of 6 cases operated upon over thirty years of age, 5 died, or 83 per cent. The analysis of Good's cases indicates the same truths; for of the cases operated upon under twelve years of age, 40.6 per cent. died; between twelve and twenty years of age, 60 per cent. died; and between twenty and fifty-eight years of age, 76 per cent. died.

Excision for hip disease in young life, therefore, is by no means a fatal operation, two out of three recovering, while from ten to thirty years of age something less than half recover, but after that period it is full of danger. The operation of excision, like amputation, lithotomy, or any other great operation, is more dangerous as age increases. The important fact that children beyond infancy bear severe operations well should ever be before us, though it is of equal importance to remember that it is in young life we meet with the best success in the expectant treatment of hip-joint as of other disease.

With the fact, therefore, before us—that in selected cases excision of the head of the femur is not only a justifiable, but a good, operation—let us briefly consider under what circumstances it should be performed; and from the general facts, as learned from statistics, we find two great results come out clearly: that in childhood the operation is attended with success, two patients out of three recovering, while in adult life it is attended with great danger, at least two out of three patients dying. In the former case, consequently, the operation may be entertained under circumstances which in the latter would render it unjustifiable. When, then, should excision of the hip be performed? And, first of all, when should it not?

Excision is **not required** where suppuration or disorganization of the joint has not taken place, because, so long as this condition is kept off by surgical as well as by medical skill, a solid hope exists that a cure of the disease may be secured, though by anchylosis.

It should **not** be performed when all evidence tends to show that the bones entering into the formation of the joint are neither extensively involved nor wholly or in part necrotic, and where the general condition of the patient, under proper treatment, is fairly maintained.

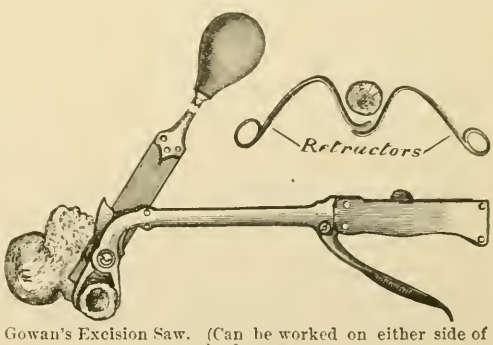
It should **not**, moreover, be entertained for disorganization of the hip-joint the result of synovial disease, unless very obstinate and extensive and the general health of the patient is clearly yielding to the disease, nor should it ever be performed for acute suppurative disease.

Excision should always be entertained when it is clear that extensive bone mischief or partial necrosis exists, it being tolerably certain under such circumstances that a cure by natural processes is highly improbable; when suppuration is persistent in spite of good treatment; when the general health of the patient is clearly being sapped by the local disease, whether that disease be in the bones or the synovial membranes, or in both; when intrapelvic abscess complicates the case; and in the majority of cases in which displacement of the head of the femur exists.

Operation.—The operation of excision is best performed by a slightly-curved incision extending from two to three inches above the trochanter along its posterior border to two to three inches below, more room being obtained when required in exceptional cases at the upper angle of the wound by a cross-incision. By this incision there is ample room for the rapid exposure and enucleation of the head and neck of the bone, and subsequently for free drainage.

Some surgeons remove only the head and neck of the femur; others take away the trochanters as well. The amount of bone does not appear to be a point of much importance, since excellent results have been obtained after both forms of practice. In the removal of the bone the chain saw is often of great use, but I prefer to saw through the bone before removing it with Adams's saw. For excisions of joints or bones generally my friend and pupil Mr. Gowan has invented a valuable and ingenious instrument; it is composed of a pair of biting forceps for holding the bone, and a saw which works upon a rotating shield fixed to the forceps. By it a bone can be divided when seized with rapidity and safety. (*Vide* Fig. 633.) The surgeon should preserve all the soft parts around the bone as much as possible; and when the periosteum can be saved, so much the better. Dr. Sayre of New York, who has paid special attention to these cases, describes his operation as follows (*Brit. Med. Journ.*, July, 1871): "When the disease has gone on to another stage where sinuses have occurred and discharge pus, when a probe leads down to dead bone, there is nothing to be done but to exsect it by making a small incision above the trochanter major, midway between it and the crest of the ilium, over the top of the acetabulum—a semilunar incision, the belly of the curve covering the posterior part of the trochanter major, going straight down to the bone *through* the periosteum; you then pull the soft tissues on one side, and, taking a small but strong curved bistoury, go as far round the bone on each side as you can reach, at right angles to your first incision, *so as to divide the periosteum completely*. You then take a strong, firm periosteal elevator with a large handle and the end slightly curved, and go into this little triangle; you peel off the periosteum, and, as a matter of course, all the muscles with it; by opening the joint thoroughly and turning the head of the bone out the periosteum is peeled off from the inner portion; you then saw off the bone above the trochanter minor, taking away the head and neck of the bone with the trochanter major. After the operation, if you keep the leg pulled out to its proper length by putting on a pair of wire breeches, you can send the patient out into the air the next day." I have given this operation in Dr. Sayre's own words, and am disposed to think as well of it as of his general treatment of hip disease. His wire breeches, however, I have never used.

Fig. 633.



Gowan's Excision Saw. (Can be worked on either side of the forceps.)

When the acetabulum is diseased—that is, necrosed—it may be removed. In many of my own cases I removed large portions of the bone, and in one the whole floor, with a good result; indeed, there is reason to believe that when the bone can be removed the case is not rendered more hopeless, for, as Holmes has well pointed out, there is always a strong fascia which separates the floor of the acetabulum from the cavity of the pelvis and prevents all contact with the viscera or their cellular connections.

After-Treatment.—After the operation the wound had better be left open to granulate, whilst good extension should be applied during the whole healing process and for some weeks subsequently. My results since I have followed this practice have far exceeded those I obtained previously. My own double interrupted splint is the best for the purpose (Figs. 572, 620). As soon as the parts have thoroughly healed passive move-

ment may be allowed, and it is remarkable to what an extent useful movement is often secured, the patient being able not only to walk upon the limb, but to flex, abduct, and adduct it nearly as well as he did before, shortening being the only fault.

Amputation at the hip-joint may be entertained in hip disease when all hope of a cure by natural processes, however ably assisted by art, has been abandoned, and when the powers of the patient admit of a reasonable hope of recovery, also in cases where excision has been performed and failed. Under these circumstances it is often very successful.

Excision of the hip-joint for gunshot or other traumatic affections of the joint cannot be recommended. The report of Dr. Otis, in the admirably got-up circulars of the War Department of Washington (No. 2), proves this to demonstration; for out of 85 cases, only 8 recovered, 90 per cent. having proved fatal. At the same time he shows that neither by the expectant treatment nor by amputation do better results ensue. He concludes that excision of the hip may be performed in uncomplicated cases of gunshot fractures of the joint—that if unsuccessful it relieves pain and is attended with less risk than amputation, although life is probably prolonged for a longer period by the expectant treatment. Professor Langenbeck, however, shows in his able essay on gunshot wounds of the hip-joint, as translated by J. West of Birmingham, that, while of 88 cases in which conservative treatment was employed 71 per cent. died, out of 31 cases treated by resection 83 per cent. died.

Treatment of Suppuration of the Knee-Joint.

It may safely be asserted that in no case of inflammatory disease of the knee-joint in which disorganization has not taken place should the idea of operative interference be entertained, as, so long as this change is warded off, a reasonable hope of a cure with either a movable or a stiff joint, and consequently with a useful limb, exists. Exceptional cases may be seen in which this rule is inapplicable, but they are rare.

When, however, suppuration has taken place, the question of operative interference naturally suggests itself; and the surgeon considers whether natural processes are competent to conduct the case to a successful issue, whether the local disease is of such a nature as to be incurable unassisted by art, or the general powers of the patient are sufficient to bear up against the demands that of necessity will be made upon them in the progress of a natural cure, and last, but not least, if it is expedient to make the attempt.

These questions require for their solution much knowledge, thought, and judgment, a careful weighing of the probabilities of the case and of the cause of the disease. When the disease is in the synovial tissue alone and the powers of the patient are good, a cure by natural processes assisted by art is generally to be secured, for pathologically in such cases there is no reason why recovery should not take place, whereas, on the other hand, when the disease has originated in the bone, spread to the synovial membrane, and been followed by disorganization of the joint, a cure by natural processes is so improbable that the removal of the diseased part by some operation is generally demanded, for pathologically good reasons exist why recovery cannot take place, and clinically this observation is borne out.

It is true that in suppuration of a joint from synovial disease, pulpy or otherwise, the result of a so-called rheumatism settling in the knee, or of a puerperal synovitis, a traumatic synovitis, a gonorrhœal synovitis, or any other, a cure with anchylosis is by no means uncommon; yet in all these, during their acute stage, the danger is always great, and it often becomes a question whether an amputation is not needed to save life or to give the patient a chance. Amputations, however, undertaken for acute suppurative disease are mostly fatal, and operations of excision are likewise equally unsuccessful. Indeed, I hardly think either of these operations justifiable under such circumstances, and in this opinion most are agreed. What I believe to be a better practice is making a free incision into the joint—free enough to let out the pus that it contains, as well as to allow a free escape of all as it forms—and the introduction of a drainage tube, together with the daily washing out of the joint with iodine water. No retention of pus should be allowed under any circumstances.

When suppuration has been set up in a joint from the degeneration of the pulpy synovial disease, the benefit of a free incision is very great, and it should be practised with a good hope of success before any other operative measure is undertaken. When, however, suppuration in a joint has followed the extension of inflammatory mischief from the bones, the hope of securing a good result without operative interference is very slender, since, as a rule, dead bone exists in the joint to keep up irritation, and as long a

it remains a recovery is very improbable. It is true nature does much in many cases toward this end, but she is rarely competent to effect the cure without surgical aid.

In the following cases these points are well seen:

CASE.—DISEASE OF THE KNEE-JOINT—SUPPURATION—REMOVAL OF NECROSED BONE FROM THE JOINT—RECOVERY WITH ANCHYLOSIS.

James W——, æt. 17, came under my care in May, 1866, for disease in his right knee-joint, of one year's duration, which had followed a fall upon the part. Swelling appeared directly after the accident, attended by severe constitutional disturbance and local pain. Suppuration also rapidly followed, and several large openings made their appearance eight weeks after the accident. When I saw him, the joint was enlarged from inflammatory thickening of the soft parts, and was clearly undergoing anchylosis. The sinuses were discharging, and a probe passed into one readily detected dead bone in the joint. In September the man was admitted into Guy's under my care, and on October 13, through a moderate incision made on the inner side of the patella, two flat pieces of what were clearly the articular facets of the tibia were removed. Rapid recovery and firm anchylosis of the joint followed.

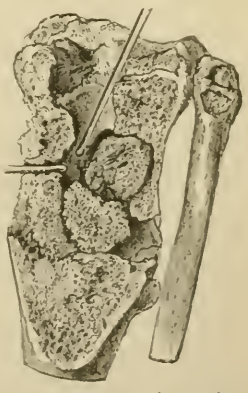
CASE.—DISEASE OF THE KNEE-JOINT AS A CONSEQUENCE OF ARTICULAR OSTITIS OF TIBIA—REMOVAL OF SEQUESTRUM FROM BONE—RECOVERY WITH AN ANCHYLOSED JOINT.

Henry R——, æt. 14, came under my care at Guy's Hospital on May 17, 1867, for extensive disease of the shaft of the right humerus and head of the left tibia, with sinuses which had existed for several years. The left knee had been enlarged from effusion for a year, but had never suppurated. When admitted, there was necrosis of the shaft of the humerus, and likewise of the head of the tibia, while dead bone was readily felt with a probe in both parts. In the tibia the bone was clearly near the joint, which was enlarged from expanded bone and thickening of the soft parts around. There was no effusion in the joint and hardly any movement in the articulation. In November, 1867, I removed a mass of diseased bone from the tibia and fixed the leg upon a splint. In January, 1868, I removed from the arm a sequestrum which included nearly the whole shaft of the humerus, and a good recovery ensued. In six months the patient left the hospital with a stiff knee and a sound arm.

CASE.—DISEASE OF THE KNEE-JOINT AS A RESULT OF ARTICULAR OSTITIS ENDING IN NECROSIS—AMPUTATION—RECOVERY.

Edward L——, æt. 14, came under my care at Guy's Hospital on September 8, 1868, for disease in the left knee-joint of seven years' standing, which had been discharging for many years. On admission the left knee-joint was completely disorganized and much enlarged; it was also partially anchylosed. Below the joint a sinus existed leading into the head of the tibia, and through this sinus dead bone was felt. The boy's health was very bad, and it was clear that nothing but amputation could be entertained. His urine was albuminous. The operation was performed on September 17, and a good recovery ensued. On examination of the joint which was disorganized the head of the tibia was found to be perforated with a channel which led from the joint to a mass of necrosed bone, and the articular facet of the tibia was likewise necrosed. The disease in the joint clearly had been secondary to the disease in the bone. The preparation is depicted in Fig. 634, and the drawing well shows the condition of the tibia.

FIG. 634.



Abscess of Tibia burrowing into Knee-Joint, with Necrosis.

REMARKS.

These three cases well show the results of articular ostitis when passing on to necrosis in the knee-joint and fairly indicate the kind of practice that should be applied. In the first case nature had done her utmost toward obtaining a cure, the knee of the patient being on admission partially anchylosed; and had it not been for the presence

of the necrosed articular facets of the tibia, a complete natural recovery would have taken place. The surgeon's duty in this case was clearly to remove from the joint what seemed to be the sole obstacle to a natural recovery—the necrosed bone; and the complete success of the treatment justified the step, for the boy ultimately had an admirable limb. In the second case the disease was of precisely the same character, and natural processes had also done their utmost toward the establishment of a cure, but the presence of necrosed bone in this case, as in the former, interfered with the recovery and prevented its realization. On the removal of the bone from outside the joint natural processes went on without interruption toward the attainment of their end, and a complete recovery with anchylosis was obtained. In the last case the same cause, articular ostitis, and the same result, disorganization of the joint, were clearly present; but the local disease in the bone was too extensive to allow of any hope of good being derived from its removal, while the general condition of the patient was too precarious to allow of the attempt. As a consequence, the only operative interference that seemed justifiable was carried out, and the issue of the case was all that could be desired. In disorganization of a knee-joint, therefore, the result of articular ostitis, of an abscess in the epiphysial extremity of the bone bursting into the joint, of disease in the epiphysial cartilage between the shaft and epiphysis, or of a sequestrum in one or other of the bones entering into its formation, some operative measure is usually required: and when the diagnosis of the case is tolerably clear, the practice ought to be decided, as delay cannot be of any use. The disease must be removed. What ought that practice, then, to be? Should it be excision or amputation? Let us refer to facts to help us toward a solution of these points. I have a table of 294 cases of *amputation of the thigh* for chronic disease of the knee-joint at various ages, and Sir W. MacCormac tabulates 137, the total making 431. Of these, 96 died and 335 recovered, the mortality being 22 per cent., or 1 in 5. On referring to Dr. Hodges' work, I find 178 cases of *excision of the knee* undertaken solely for chronic disease of the knee, of which 70 died and 108 recovered, the mortality of excision being 39 per cent., or 1 in 2½ cases. In this comparison the circumstances are exactly similar, both operations being undertaken for chronic joint disease, and the mortality is exactly double. In my table of amputations I have carefully guarded against any fallacy and have included only my own statistics,[1] Mr. Callender's,[2] Sir W. MacCormac's,[3] and Mr. Holmes's,[4] all of which are equally indisputable; and in the table of excisions I have gone to Dr. Hodges' work, who, to make this point certain, states that, with three exceptions performed for acute inflammation of the articulation, excision of the knee has probably never been undertaken for any other than chronic disease or white swelling. Mr. Swain, the author of the Jacksonian prize essay on "Excision," and a warm advocate of the operation, has given us statistics on this subject, and from his book (pp. 62 and 64) I have extracted the following facts: Up to 1865 there had been 316 cases of excision of the knee. Of this number, 85 died, or 26.8 per cent.: 9 of these died after amputation, which had been performed in 39 cases after excision. Since 1865, 74 cases are given, 25 of which died from the operation, or 33.7 per cent.: 4 also died out of 11 that underwent subsequent amputation; in all, 29 cases out of the 74 died, or 39 per cent. Mr. Swain gives us also a select list of cases numbering 82, of which 15 died from the effects of the operation, while 4 others recovered after amputation. We have thus 472 cases of excision of the knee, and 129 deaths, or 27.3 per cent., 13 of these being after amputation: 41 other cases underwent amputation and recovered. Taking the whole number of 472 cases, 302, or 63.9 per cent., recovered after excision; 41, or 8.7 per cent., recovered after secondary amputation; 129, or 27.3 per cent., died after excision. The mortality from excision was thus greater than from amputation in the same class of cases, the relative proportion being 27 to 22 per cent. "It is also," adds Holmes, "a somewhat suspicious feature in Mr. Swain's table that all the 302 recoveries are claimed as being with useful limbs. If the information had been at all adequately full, there would surely have been a category of recoveries with the limb more or less useless," since it is a well-known fact that in many cases in which it seemed perfect at first the utility of the limb becomes destroyed by subsequent changes. In childhood suspension of growth is not an unfrequent result: and when the whole epiphyses are removed, it is to be looked for. It is true that Mr. Swain gives somewhat different results from the same statistics, as he actually numbers amongst the recoveries after excision all cases that subsequently underwent amputation, thus, of course, giving a far too favorable coloring to the operation he is *advocating*.

[1] *Med.-Chir. Trans.*, vol. xlii.
[2] *Ibid.*, vol. xlvii.
[3] *Dub. Quart.*, August, 1868.
[4] *St. George's Hosp. Rep.*, 1866.

If, however, we look to *the results of both operations as performed at different periods of a life*—a point of comparison of immense importance, although entirely ignored by Mr. Swain and other advocates of excision (and I wish its advocates would consider well these points, and not pass them by as of no importance)—the following striking result comes out: In my own table of amputations for chronic diseases of the knee in patients under twenty years of age, out of 69 cases, only 3 died, or 4.3 per cent., or 1 in 23 cases. In excision for the same class of cases performed at the same period of life, out of 97 cases, 27 died, or 27.8 per cent., or 1 in 3½, the different degrees of mortality of the two operations under twenty years of age being as 4.3 per cent. to 27.8 per cent., *excision being nearly seven times as fatal as amputation during young life*. It may thus fairly be asked whether the advantages of excision are so great as to justify its performance in the majority of cases of disease of the knee at that age. In amputations undertaken between twenty-one and forty years of age for chronic joint disease, out of 119 cases, 38 died, or 32 per cent., or 1 in 3; in excision, undertaken under similar circumstances, out of 74 cases, 39 died, or 52.7 per cent., or more than 1 in every 2 cases, the difference between the mortality of the two operations, 32 per cent. and 52.7 per cent. respectively, being 20 per cent. against excision.

Summary.

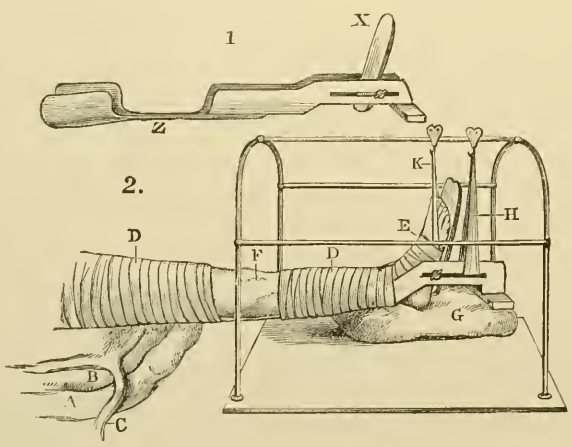
It would thus appear that it is in young adult life that excisions, although always more fatal than amputation, are the most justifiable; that in childhood they are far too dangerous; while in patients past middle age all admit their inapplicability. And yet it must be admitted that excision of the knee-joint is a good operation, and that by it, when successful, a far better limb is given than after amputation. The truth must be recognized, however, that the operation, as hitherto practised, is much more fatal than amputation, although it may with confidence be asserted that the cases in which amputation has been performed are, as a rule, far more severe than those in which excision has been practised; for the advocates of excision are disposed to operate at a somewhat earlier period of disease than the advocates of amputation—that is, the former often remove a disease they believe it is inexpedient to leave to be cured by natural processes, whilst the latter remove a limb only when all hope of a natural cure has passed away and the operation is a necessity to save life. Are the advantages of excision, therefore, so great as to justify a surgeon submitting a patient to an extra risk in order to secure them? As hitherto practised, and as a general rule in surgery, I have no doubt in answering in the negative. In exceptional cases the risk, it is true, may be run, but excision as a rule of practice does not appear to be sound. Whether better results would not be secured by an earlier operation is an open question. Prof. Humphry's cases, recently published, and those of my colleague, Mr. Howse, rather tend to show they would; for after excision undertaken with a patient in good health, or at least not worn out by suppurative mischief, a good result may fairly be expected. But is the risk of the operation when performed under these favorable circumstances so slight as to justify the surgeon in throwing aside the hope, and perhaps fair expectation, of securing a recovery by natural processes? Is excision of the knee to be an operation of expediency and not of necessity? We want facts to prove this fully, but as far as present experience goes it seems to show that if the operation is to be a successful as well as a general one in surgery it must be undertaken at a somewhat earlier period of disease than that at which the question of amputation has to be mooted—that it should be performed before surgical fever has reduced the powers of the patient and complete disorganization of the joint has taken place. In fact, it should *not* be practised when an operation is demanded to save the life of a patient—for under such circumstances a better chance is given by amputation—but when the local disease is found to be steadily progressing in spite of treatment and disorganization is threatening. As a substitute for amputation undertaken in extreme disease to save life, facts tell against the practice; as an operation of expediency to gain time, the few facts we possess tell in its favor. From recent experience I am disposed to to think that under these circumstances excision is a successful and satisfactory operation. In doubtful cases amputation is the more desirable, as it is the safer, operation; and, since the great object of our profession is to prolong and save life, other objects ought always to be subsidiary to this great aim. In acute suppuration of the knee excision is never successful. Excision for gunshot wounds has been proved to be most unsatisfactory; indeed, as a practice in such cases it seems hardly justifiable. In compound dislocation it has been successful. Canton and M. Spillman have published such cases, but upon the whole the evidence we possess is not much in its favor in traumatic cases.

Resection in cases of deformity as a consequence of disease is probably a better field for the operation, and Drs. Barton and Buck of New York have demonstrated its value.

The Operation.

The best incision is that practised by Fergusson and suggested by Park—a straight one across the joint below the patella from the *posterior* edge of one condyle to the corresponding part of the other. When the tissues over the knee are bad, the incision may be curved, forming a flap. The old H-shaped incision is now rarely practised. Humphry follows Mackenzie in making the semicircular incision with the convexity downward, and Bickersteth of Liverpool makes a vertical incision on the inner side of the patella. The joint should be opened at once by dividing the ligamentum patellæ and the capsule of the joint, an assistant flexing the leg fully upon the thigh, thereby facilitating this part of the operation. The soft parts ought then to be turned back off the patella and that bone removed, there being no object in leaving it, but many reasons for its removal. The joint having been freely exposed by the division of the lateral and other ligaments and by the forcible projection of the condyles, the lower two-thirds of the cartilaginous extremity of the femur is to be excised, care being taken not to injure the popliteal vessels which lie in close contact behind; the whole of the epiphysis should not be removed. This section is usually made at right angles to the shaft of the bones, but lately it has been suggested that the surface of the femur should be made convex and that of the tibia concave, or that of the femur should be made wedge-shaped to lessen the risk of any shifting of the bone. To make the section, the bow saw known as Butcher's is the best; the section should be made from behind forward. In both bones, when possible, it is well not to encroach upon the epiphysial cartilage. In dividing the bone care is required not to strip off the periosteum above the line of section. When the surfaces are not healthy or do not come together well, another section may be made, it being a point of primary importance that a perfect adjustment of the bones should be secured. To aid this the osseous suture, as first employed by Gurdon Buck and practised by Nélaton and some English surgeons, is to be recommended. All bleeding ought to be arrested by ligature or torsion of the vessels or by hot antiseptic sponges (a point much insisted on by Prof. Humphry) and the parts brought well together by sutures, some immovable apparatus being adjusted before the patient is taken from the operating-table. The splint I prefer is the one figured below as used by my colleague, Mr. Howse. It is made of

Fig. 635.



Splint for Excision of Knee.

1. Splint: Z, sliding bar; X, foot-piece. 2. Limb fixed in splint after operation: A, mattress; B, water-bed with pipe (C); D, waxed bandage; K, longitudinal band to support heel fixed by strapping (E); H, band to support splint; G, pillow.

tinned iron, and the limb is fixed in it by a waxed bandage. Dr. P. Heron Watson employs with the plaster of Paris an anterior iron suspension rod. Salter's swing is an invaluable adjunct.

Dr. Humphry first fixes the limb upon a posterior splint and foot-piece, then, uniting the edges of the wound by sutures, he applies well-padded long splints to the sides of the

limb, the wound being left exposed. "I am very particular," he writes (*Med.-Chir. Trans.*, vol. lii.), "to adjust things well and firmly in the first instance, and am very unwilling to disturb the limb afterward. Indeed, I frequently do not remove any of the bandages or splints for five, six, or more weeks, and by this care and perfect quiet I endeavor to promote immediate union. This perfect quiet and abstinence from removal of the bandages first applied is, I consider, a very important item in the treatment. It is equally important not to discontinue the splints till the bones are quite firmly united—till the patient can raise the limb from the bed by its own muscles without any movement being perceptible between the tibia and femur. It is necessary to make quite sure of this."

Dr. Humphry adds that "excision of the knee is not an operation of much danger," but it must be remembered that he has little or no faith in the cure by natural processes. He believes such a cure in the bulk of cases to be hardly worth the attempt, and advises that excision should be employed early, so as to bring about by operation that condition which we would gladly see attained without such interference.

Suppuration of the Ankle-Joint.

When the *ankle-joint* has undergone disorganization and is suppurating, the benefit to be gained by a free incision into the joint is very great, a cure with a movable articulation being often obtained by these means. When this end is not secured, a recovery by anchylosis may be looked for, it being exceptional for any more active interference to be required except when the bones are extensively involved.

When necrosis of one of the bones entering into the formation of the joint is present, recovery may be looked for on the removal of the diseased bone. In the case illustrated in Fig. 636 I removed the necrosed upper half of the astragalus with an admirable result, and a good foot, with some amount of movement, was secured.

Fig. 636.

Foot after Removal of Necrosed Astragalus from a Child æt. 6.

Under these circumstances excision of the joint has been practised, and with success. I have performed this operation on three occasions, and in two with a good result; in the majority of cases of disorganized ankle-joints I have obtained good results by the expectant treatment and free incision. Excision may be expected to be successful when the disease is limited to the articular surfaces of the bones, and it is in such that the treatment by incisions and the expectant principle is so successful. When the disease is very extensive, it is still a question whether amputation is not probably a better practice. Stokes, however, has collected 51 cases of excision, 38 of which were successful, and in the *Dublin Quart.* for 1870 an excellent example by Dr. Murney may be referred to.

In cases of injury, of compound dislocation, and fracture into the joint excision is probably a sound operation. Mr. H. Lee has recently adopted it in two cases, and Langenbeck has practised it freely with success. Hancock (*Lancet*, 1867) gives nineteen successful examples of the operation, quoting Heyfelder and Jaeger's practice in its support. In such cases, however, it seems well to practise it as a secondary operation.

With respect to the operation itself, I may quote Hancock's, as practised in 1851, and given by Barwell with recent improvements.

The foot is first laid on its inside and an incision made over the lower three inches of the posterior edge of the fibula. When it has reached the lower end of the malleolus, it forms an angle and runs downward and forward to within about half an inch of the base of the outer metatarsal bone. The angular flap is reflected forward; the fibula, about two inches above the malleolus, is thus sufficiently cleared of soft parts to allow cutting forceps to be placed over it, when the bone then can be nipped in two and carefully dissected out, leaving uncut the tendons of the peronei longus and brevis. The foot must then be turned over. A similar incision should be made on the inner side, the portion in the foot terminating over the projection of the inner cuneiform bone. The flap ought then to be turned back and the sheaths of the flexor digitorum and posterior tibial tendons exposed, the knife being kept close to the bone, avoiding the artery and nerve. The internal lateral ligament should be severed carefully close to the bone; and the foot is now twisted outward, when the astragalus and tibia will present at the inner wound. A narrow-bladed saw inserted between the tendons into the inner wound will project through

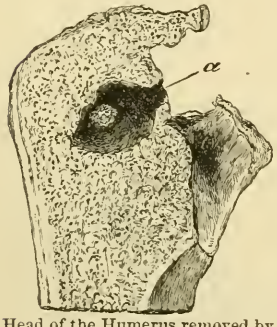
the outer. The lower end of the tibia, and then the top of the astragalus, should be sawn off in a proper direction. The only vessel that may require tying is one of the lower branches of the peroneal artery. The wound can be closed with sutures, except that part opposite the breach of osseous matter, and the leg and foot placed in a splint with a foot-board and cold water applied. Mr. Hancock points out the superiority of total over partial excision of the joint. Mr. Hey of Leeds in 1766 was the first surgeon who resected the lower ends of the tibia and fibula for compound dislocation, and Moreau in 1792 for disease. Hancock, however, was the first to resect the joint as a whole. This operation has grown in favor during the last few years, and in select cases is doubtless beneficial.

Suppuration of the Shoulder-Joint.

Suppuration of the shoulder-joint is as successfully treated by free incisions into and the removal of necrosed bone from the joint as the same affection of any other articulation, and only when this treatment has failed or is inapplicable are more severe measures required.

In the case from which Fig. 637 was taken the disease had evidently commenced as an abscess in the head of the bone, which had made its way into the joint and downward through the soft parts to a point below and behind the insertion of the deltoid muscle. It had existed for a year before I treated it, and nothing but excision was applicable, since the abscess cavity contained a small sequestrum which could not get out. After the operation the patient had a good arm.

Fig. 637.



Head of the Humerus removed by Operation, showing an Abscess Cavity (*a*) in its Centre, with Small Sequestrum and Sinus burrowing Downward.

Excision of the shoulder-joint—or, rather, of the head of the humerus—is an excellent operation in gunshot wounds of the joint, in compound dislocation, or in cases of disease where a cure by natural processes has failed after judicious treatment, owing either to the extent of disease in the bone or to the general feebleness of the patient's powers. "The ultimate results of excision of this joint, whether for injury or disease, are very satisfactory," says Hodges, but they are not more so than the ultimate results of a cure by natural processes, even with anchylosis; for, whatever may be the capabilities of an arm after excision, they are equalled after a natural cure. Under both circumstances, in the majority of cases, almost every movement can be effected except any overhand one, since the arm cannot be raised above the shoulder. A man whose shoulder I excised fourteen years ago was a coachman in 1872 and could drive a pair of horses with ease. A man upon whom Mr. Key operated was subsequently able to carry on his occupation as a hammerman at a large engineer's, and another case, operated upon by the same surgeon twenty-one years before, in June, 1869, could "shoe horses with any man," and as a blacksmith felt no want in his arm.

In gunshot injuries to the shoulder excision is now a recognized operation, the experience acquired in the American war having decided the point. Dr. Otis (Circular 6) has recorded that in 252 cases of primary excision, 23 per cent. died; and in 323 secondary, 38 per cent.; primary excisions being thus more successful than secondary.

In cases, also, of tumors involving the head of the bone, other than cancerous, excision is an operation of value.

Operation.—The best incision is the vertical, from the acromion process through the thickness of the deltoid down to its insertion. Some make an anterior in front of the deltoid. Nélaton used the transverse and Aston Key the deltoid flap. When the vertical incision is made down to the bone, its head should be successively rotated outward and then inward, the surgeon making a transverse cut across the tuberosities to divide the insertions of the scapular muscles. The capsule may then be divided and the head of the bone turned out of the wound and resected through the tuberosities. The long tendon of the biceps needs no special attention, as in cases of disease it has probably long gone or become fixed to the groove, and after resection of the joint is of no value. When the glenoid cavity is diseased—that is, when dead bone is detected in it—it should be removed; but, in a general way, it requires no treatment. When the vertical incision is employed, it is expedient to make an opening posteriorly through the soft parts, at a point

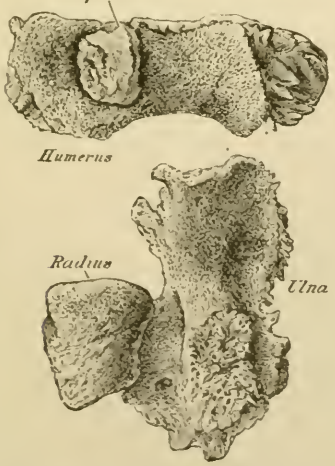
corresponding to the upper end of the humerus, for the purposes of drainage, this opening being kept patent by means of a drainage tube. Whatever vessels are divided should be twisted, and the posterior circumflex artery at times gives trouble. After the operation the arm should be abducted and placed on a pillow, the edges of the wound carefully brought together, and water dressing or dry lint applied. As soon as repair has fairly taken place the patient may get up, the arm being well supported in a sling. Three or four months, however, are usually required before a useful arm is secured.

In this operation M. Ollier makes much of preserving the periosteum, turning it back off the bone with all the soft parts by means of raspatories; this is not so difficult in cases of disease as might be fancied. A cut with a strong knife down to the bone should so divide all the soft tissues over the bone as to give admission to the edge of a raspatory for the purpose of turning them back. Ollier has done this on four occasions with success. In resecting the bone no more need be removed than is necessary beyond the head and half the tuberosities; but when the section is not healthy, another may be made. Four or five inches of bone have been removed in some cases, and yet a useful limb remained.

Suppuration of the Elbow-Joint.

There is a great difference amongst surgeons as to the treatment of a suppurating elbow-joint. In the Scotch school excision is employed very freely, under the belief that a better arm more generally follows such a practice than results from a cure by natural processes, and that a joint with better movement is secured in a shorter time. I cannot say that I agree in this opinion, for in elbow-joint disease, where pus is let out by free incisions and good reparative power is present, recovery with a movable joint, and one admitting of pronation and supination of the hand, is by no means uncommon. In other cases anchylosis of the humero-ulnar joint may take place at a good angle and pronation and supination of the hand be retained—and when this is the case, the issue so far as the usefulness of the hand is concerned is excellent—while in another class anchylosis of both bones may take place with a very useful arm; and this result is secured by no greater expenditure of time than is required for repair after excision, and without the risks of an operation. In synovial disease ending in disorganization this termination is far from being uncommon. Indeed, in such cases excision is rarely called for. In bone disease ending in necrosis, however, the same rules do not apply, for under such circumstances no operation is of greater value than excision (Fig. 638). In Fig. 638 the disease was necrosis of part of the humerus; in Fig. 639 necrosis of the head and neck of the radius.

Fig. 638.



Parts Removed after Disorganization of the Elbow-Joint as a Result of Necrosis of Humerus.

Fig. 639.

Necrosis of the Head and Neck of the Radius, followed by Disorganization of the Elbow-Joint. (Removed by resection from a man æt. 36.)

In all cases of disease of the elbow-joint in which natural processes are incompetent to effect a cure excision should be performed, amputation being had recourse to only when excision is inapplicable or has failed. In cases of compound dislocation or fracture

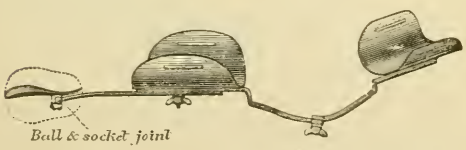
into the joint excision is an excellent operation, and to gunshot wounds the same observations apply. Amputation of the arm for injured elbow ought to be performed in quite exceptional cases. Several inches of bone may be taken away in the operation. Mr. Tudor of Dorchester removed five inches, the patient subsequently having an arm capable of extensive motion in every direction, and with which he could lift a heavy chair (*Med.-Chir. Trans.*, 1858).

Operation.—The best incision is the vertical one over the olecranon process, as practised by Langenbeck and the French surgeons, extending from three inches above to two below the joint, the incision dividing all the tissues down to the bones. The soft parts should then be carefully separated from the bones and drawn aside, the ulnar nerve being raised from the inner condyle, with the inner half of the triceps tendon and fascia. *No transverse incision across the triceps tendon should be made*, it being a very important thing, as recommended by Dr. R. Hodges of America (*Hammond's Essays*, 1864) and demonstrated by Maunder (*Brit. Med. Journal*, 1871), to retain the triceps tendon and fascia as it passes over the olecranon, with the fascia of the fore-arm and anconeus muscle, a thick body of muscle and fascia being in this way retained, extending from the arm above to the fore-arm below, which adds materially to the extending power and subsequent value of the limb (Fig. 640). The articular ends of the bones should then be turned out and removed. The surgeon need not be too sparing in his sections. In all cases the whole of the articular facets should be resected; and when the bone at the point of section is not quite healthy, a second piece had better be removed. "If only the extreme ends of the bones be sawn off, anchylosis will most likely take place; while if the amount above prescribed—viz., the whole condyloid extremity of the humerus and all the sigmoid cavity of the ulna, with the head of the radius, or even little more on both sides—be taken away, free motion may, under favorable circumstances, be expected" (Fig. 641) (*Holmes's System*, vol. v.). I have at times regretted not having excised enough of bone, and particularly of the humerus; indeed, I strongly advise the surgeon in all cases to be free in his section of this bone, more particularly in excisions for anchylosis. When possible, it is well to preserve the insertions of the biceps and brachialis anticus tendons by pressing them back from the bones. To preserve the periosteum in the operation, as advocated by Ollier and Langenbeck, does not appear from published facts or scientific reasonings to be a matter of importance.

Fig. 640.

Vertical Incision for Excision of the Elbow-Joint. (From Maunder.)

Fig. 641.



Splint for Excision of the Elbow, the Splint allowing every movement.

After-Treatment.—After the operation, all hemorrhage having been arrested by torsion and the application of cold or very hot water, or, what is preferable, iodine water (℥ij ad Oj, this mixture checking capillary bleeding), the edges of the wound should be brought together at their ends, a drainage tube introduced, and the arm fixed at an obtuse angle upon such a screw splint as that made for me and figured above (Fig. 641, the splint allowing every movement), moderate pressure being applied and maintained for a few hours by means of a bandage. Absolute rest should be maintained till the wound has fairly healed and the powers of the patient have been restored, when passive movement should be commenced with pronation and supination of the hand, the object of this operation being not only to remove the disease, but to obtain a movable joint. When anchylosis follows, the operation in a measure is unsuccessful, for it has failed in one of its greatest advantages. In the most favorable cases the amount of movement that is obtained is all that could be wished; indeed, it is little less than that of the healthy joint. In some cases, however, the joint is too loose, like a flail; in others it is stiff; whilst in another class flexion and extension are good, but pronation and supination fail. In Mr. Syme's case of a man who had acted as a railway guard up to the time of his death, nine years after the operation, when the joint was dissected, the ulna and humerus were united by ligamentous union, and the end of the radius was polished off and placed on the humerus and ulna upon a material much resembling cartilage. If the ulnar nerve be injured, much wasting of the muscles must occur; if divided, union of the ends may, however, take place. Syme has recorded such a case. When disease returns,

a second resection may be performed, and even a third. When dead bone follows, it may be removed; indeed, nothing should be left untried before amputation is practised. I have performed the operation twenty-five times, and have never had to resect a second time or to amputate, and in two-thirds of the cases good movement was obtained.

Partial resections of the elbow have hitherto been condemned, past experience having indicated that they almost always end in anchylosis of the joint. In 1861, however, my colleague, Mr. Birkett, excised the olecranon for local disease following an injury, the man recovering after many months' treatment with a slightly movable articulation; and I have recently (1877) done the same in a barrow-man æt. 38, the patient recovering with a joint fixed at a very obtuse angle, with limited movement. I have likewise removed the necrosed olecranon process from a disorganized elbow-joint of a woman with a good result, the humerus and ulna subsequently anchylosing, while the radius and hand retained all their movements. From the results of partial resections in other joints as well as in the elbow I believe, however, that with our present improved methods of treating wounds these partial operations are valuable.

Suppuration of the Wrist and Carpal Joints.

In this affection operative interference is rarely called for beyond free incisions for the evacuation of pent-up pus and removal of dead bone, recovery being aided by the absolute immobility of the hand and fingers and such constitutional remedies as the wants of the individual case suggest. When, however, such means fail or the local disease is too extensive or severe to allow of a natural recovery, excision of the joint should be performed: Lister, Hancock, and others have had successful examples. The best method of performing the operation is that of Langenbeck, by means of a single free incision over the dorsum of the wrist extending along the centre of the metacarpal bone of the index finger. By this incision the lower part of the radial artery is avoided and ample room given for the completion of the operation. Through the opening made the carpal bones can readily be turned out and the bases of the metacarpal bones, with the extremities of the radius and ulna, excised, the tendons of the wrist being held aside with ease. In performing this operation I have been struck with the facility with which it can be effected, and believe it to be preferable to the comparatively difficult and complicated method suggested by Lister, which is to be commenced by an incision made in front over the second metacarpal bone internal to the tendon of the extensor secundi internodii pollicis and running along the back of the carpus, internal to the same tendon as high as to the base of the styloid process of the radius; the soft parts, including the extensor secundi internodii and the radial artery, being cautiously detached from the bone, external to this incision, and the tendons of the radial extensors of the wrist being also severed from their attachments, the external bones of the carpus will be exposed. When this has been done sufficiently, the next step is to sever the trapezium from the other bones with cutting pliers, in order to facilitate the removal of the latter, which should be done as freely as is found convenient. The operator now turns to the ulnar side of the incision, and cleans the carpal and metacarpal bones as much as can easily be done. The ulnar incision is then made; it should be very free, extending from about two inches above the styloid processs down to the middle of the fifth metacarpal bone and lying near the anterior edge of the ulna. The dorsal line of this incision is then raised along with the tendon of the extensor carpi ulnaris, which should not be isolated from the skin, but cut as near its insertion as possible. Afterward the common extensor tendons should be raised and the whole of the posterior aspect of the carpus denuded until the two wounds communicate freely together, though the radius is not as yet cleaned. The next step is to clean the anterior aspect of the ulna and carpus, in doing which the pisiform bone and hooked process of the unciform are severed from the rest of the carpus, the former with the knife, and the latter with the cutting pliers. In cleaning the anterior aspect of the carpus care must be taken not to go so far forward as to endanger the deep palmar arch. The ligaments of the internal carpal bones being now sufficiently divided, they should be removed with blunt bone forceps; next, the end of the ulna is made to protrude from the incision and sawn off as low down as is consistent with its condition, but in any case above its radial articulation. The end of the radius can then be cleaned sufficiently to allow of its being protruded and removed. If this can be done without disturbing the tendons from their grooves, it is far better. If the level of the section is below the upper part of the cartilaginous facet for the ulna, the remainder of the cartilage must be cut away with the pliers. The operator next attends to the meta-

carpal bones, which are pushed out from one or the other incision and cut off with the pliers, so as to remove the whole of these cartilage-covered portions. The trapezium bone, which was left in the early stage of the operation, can now be carefully dissected out, so as to avoid any injury to the tendon of the flexor-carpi radialis or to the radial artery, and the articular surface of the first metacarpal bone then becomes exposed and removed. Lastly, the cartilaginous portion of the pisiform bone is taken away, but the non-articular part is left, unless diseased, in which case it should be entirely removed. This remark applies to the hooked process of the unciform. No tendons are divided in this operation except the extensors of the wrist.

After-Treatment.—In order to ensure motion of the fingers passive movements should be performed from a very early period after the operation. For this purpose Lister places the limb in a splint with the palm of the hand raised by a wedge of cork fixed below it, so that the joints of the fingers can be moved without taking the limb off the apparatus. When the splint is removed, some flexible support is required for some time. (*Vide* Lister's paper, *Lancet*, 1865.)

Excision of the joints of the thumb requires no description, and may be made by a vertical dorsal incision that interferes but little with the tendons of the part. The operation is very good, and should always be performed where possible for disease or injury. I have done it on many occasions with a good result, and at times recovery has been followed by movement. In the case of a man with neglected dislocation in which I performed it, hermetically sealing the wound with lint and the compound tincture of benzoin, rapid recovery followed with a movable joint. In a second case, in which I excised the phalangeal joint of the thumb, a like result ensued.

Amputation in Joint Disease

ought never to be resorted to until all hope of a cure by natural processes has been given up or failed—until incision into or the removal of necrosed bone from the joint has been deemed unsuitable, excision of the joint inexpedient or inapplicable, or the progressive nature of the disease and its sapping powers reveal the fact that if the disease be not removed the life of the patient is likely to be sacrificed. In amputating for joint disease, as for injuries, tumors, or other causes, the principles of "the least sacrifice of parts" should be followed, and no more of the body, under any circumstances, ought to be taken away than the necessities of the case demand. To carry out this principle the surgeon may, in pathological amputations, fearlessly divide tissues infiltrated with organized inflammatory products, and even cut through the walls of suppurating cavities or diseased joints, more particularly to save amputating above a joint. The value of this practice I have fully illustrated (*Lancet*, January 23, 1875).

Amputation for disease of the hip, shoulder, and elbow-joint is performed only in exceptional cases, and for the knee and ankle it is yearly becoming less common. Yet it is a valuable operation in proper cases, as well as the means of saving many lives. The mortality of amputation for chronic knee-joint diseases at Guy's Hospital is only 1 in 7, and in young people under twenty years of age 1 in 20. In amputation for disease of the knee, where the end of the femur is sound and the articular facet alone diseased, the surgeon should sacrifice as little of the thigh as possible; the amputation should be almost at the joint, and the femur divided through its condyles, or just above, as in Stokes's amputation; a higher section of bone should be made only when the necessity of the case demands it. In disease of the ankle-joint, when excision and every smaller operation, such as the removal of dead bone, has been put aside, Pirogoff's operation should be employed in preference to amputation, if the calcis with the integument over it be sound, or Syme's amputation unless the disease of the articular end of the tibia is too extensive. To amputate a sound foot for disease confined to the ankle-joint is a measure which can be justified only by peculiar circumstances, and as a general practice it is to be condemned. Amputation of the arm for diseased elbow is still less justifiable, unless the local disease is too extensive to allow of excision or the powers of the patient are too feeble to admit of the attempt.

LOOSE CARTILAGES IN THE JOINTS.

Loose bodies, ordinarily called loose cartilages, are found in joints and are most common in the knee, yet are met with in the elbow-, ankle-, and other joints. They are, doubtless, generally developed in the sub-synovial cellular tissues, and as they increase

in size encroach upon the cavity of the joint by pushing the synovial membrane before them, and appear as warty or more or less pedunculated fringed growths hanging into the cavity. They may be single or multiple and of all sizes up to that of a small walnut. When one of the masses becomes detached, "a loose cartilage" is said to be present. John Hunter taught, and Rokitansky believed, that they are formed by the organization of fibrinous coagula; but evidence is wanting to prove this view, for most, as pointed out by Rainey, contain ill-formed cartilage cells, and ossific matter and true bone-lacunæ are at times present (Fig. 642). Paget (*St. Barth. Hosp. Rep.*, 1870) has recently given good evidence of the truth of Teale's suggestion that some of these bodies are really sequestra, and that "just as a blow on bone or tooth may induce necrosis and exfoliation without signs of destructive inflammation, so may it with articular cartilage; and the characteristics of these cases will be that after injury to a previously healthy joint a loose body is found in it, having the shape and general aspect and texture of a piece of articular cartilage, with or without some portion of subjacent bone, and with its cartilage corpuscles arranged after the manner of the articular cartilage." Dr. Adams of Dublin connects their presence with osteo-arthritis.

FIG. 642.

Nat. size

Section of Loose Cartilage removed from Knee. (Prep. 134.[59], Guy's Mus.)

A report upon these bodies, with microscopical drawing kindly etched for me by Dr. Goodhart, will help to the solution of some of these points:

"The term 'loose cartilage' is applied to two conditions which are totally distinct—the one where a portion of the normal articular cartilage has been detached by injury to the joint and lies loose in its cavity; the other where bodies of more or less consistence, often cartilaginous or bony, are found, and which are new formations.

"Recent observations seem to show that the former of these two is by no means of infrequent occurrence, but it possesses no pathological interest whatever and needs no description. A very good specimen of this form is to be found in the Guy's Hospital Museum (1344[62]). The latter, however, has frequently excited discussion among pathologists; so we will give in a few words what appears to be its usual composition and our conclusions therefrom as to its mode of origin. Roughly speaking, loose cartilages are generally more or less smooth, of grayish color, and look, as their name suggests, like pieces of cartilage; but they may be nodulated and composed almost entirely of bony material (Fig. 642 and Prep. 956B, Hunterian Mus.). Even in that case, however, they have a thin film of fibrous material over them still, obscuring the bone and rendering them cartilaginous-looking on their external surface.

"The cases (five in all) that we have had an opportunity of examining have also shown more or less calcareous matter; they were never pure cartilage. One case in the Guy's Museum (1344[20]), while appearing cartilaginous, cut with a creaking sensation, and under the microscope irregular deposits of calcareous matter and bone were found in all directions in its substance. In another (Hunterian Museum Cat., 957A) one surface is tuberculated and composed of hard nodules of ivory-like bone, while in a concavity thus formed is a cartilaginous mass. The bone on the surface in this specimen can only be compared to the nodulated excrescences found at the margins of the articular cartilages in cases of osteo-arthritis.

"The microscopical characteristics vary in each to a certain extent: some show fibro-cartilage, calcareous matter, and bone; others are entirely bony. The cartilage in the specimens which we have examined was very fibrous and the cartilage-cells small. The calcareous matter had evidently not formed after any definite method or in any purposive direction, as should occur in the building up of normal bone-tissue, and the bone had no regular system of Haversian canals or bone corpuscles. The former occur as spaces of irregular shape and position, and the corpuscles, with but few canaliculi, are often more like calcified cartilage corpuscles and have no arrangement in relation to them.

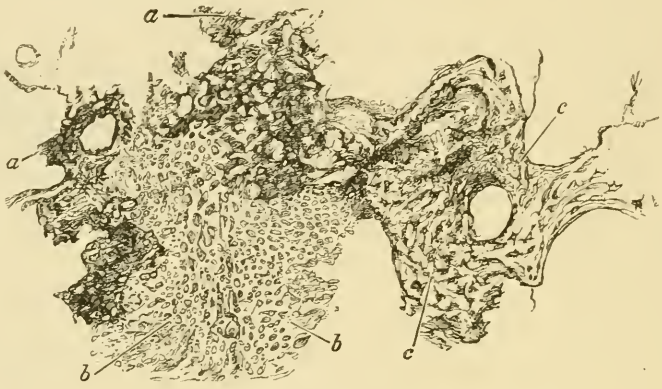
"From this short description, and also from Fig. 643, it will be seen that the specimens exhibit the formation of bone in its various stages: they show the primary cartilage stage, the secondary calcareous stage, and its ultimate issue in true bone, the bone being, as might be expected, of a somewhat irregular build.

"Having thus regard to their general structure, it would then seem most probable that, since they are in their essence bony, loose cartilages must form in connection with bone-forming tissue, and these, so far as is known, are found in the involutions of the synovial membrane at the edges of the articular cartilages. This view is consistent also with the appearances found in certain joints in cases of osteo-arthritis—such, for instance, as a case recorded by Mr. Wagstaffe in the *Pathological Society's Transactions* (vol. xxiv.,

1873, p. 192), or specimens 954–956B in the museum of the Royal College of Surgeons. In all these the formations may be seen *in situ*. It is also in accord with the generally-received opinion as to the more usual formation of loose cartilages at the present time.

"But in connection with this subject the so-called 'melon-seed bodies' found in joints and in the synovial sheaths of tendons and on bursæ must be considered. As is well

FIG. 643.



Microscopical Appearance of Loose Cartilage. *a*, Calcareous matter. *b*, Small-celled cartilage, in parts more fibrous than represented. *c*, Bone.

known, they are generally abnormal developments of the synovial fringes, sometimes inflammatory, sometimes, perhaps, as was suggested by Rokitansky, due to cystic dilatation of the synovial folds, or perhaps to distension and coagulation within obstructed follicles. But whether originating in one or all of these various ways, being all in common due to changes in the synovial membrane and sub-synovial tissue, it is evident that they are loose cartilages in miniature and only want size and the further change into cartilaginous matter to be true loose cartilages. But I have lately had an opportunity of making a very careful examination of some of these 'melon-seed bodies' from one of the sheaths of a tendon on the dorsum of the hand, which suggested the possibility, not to say probability, of another mode of origin. I failed to find in any of them any evidence of organized tissue whatever. They contained no nuclei or cell elements and were entirely composed of a faintly fibrillated hyaline substance characteristic of coagulated mucus or fibrin. Hence it seems to be quite possible that loose cartilages may originate in a nucleus of fibrin precipitated in the course of a chronic inflammation, and that they subsequently grow by accretion, becoming calcareous by central petrifaction. On this point may be consulted a very interesting case of a loose body in the peritoneum recorded in the *Path. Soc. Trans.* by Dr. Greenhow (vol. xxiii. p. 241). This specimen, in conjunction with 'melon-seed bodies,' makes one reconsider whether the opinion formed originally by John Hunter may not be correct—that loose bodies in the joints are sometimes formed from the 'living principle of the blood.'"[1]

SYMPTOMS.—Loose bodies, however formed, give rise to very similar symptoms, produced by the foreign body becoming fixed and pinched between the articular surfaces of the bones. The presence of one of them is usually discovered, when the patient is walking or moving the joint, by some sudden inability to move the articulation and a severe and sickening pain, which is relieved only by the cartilage slipping from between the bones, which it usually does by a characteristic snap.

Some stiffness and slight inflammation of the joint may follow this injury, which by rest and treatment will subside in a few days, to be renewed upon a recurrence of the accident. In such a joint as the knee the cartilage may as often as not be felt on manipulation, although readily slipping away under pressure.

TREATMENT.—The treatment may be described as palliative or operative. By the former the cartilage is left untouched in the articulation, and by the latter it is removed or fixed in an unoffending position. In a general way, the palliative treatment is the correct one to be enforced; for, knowing how destructive inflammation of a joint following a wound too often proves, few surgeons would venture upon an operation without an abso-

[1] For further information *vide* Virchow's *Krankhaften Geschwülste* (vol. i.); Marsh, *St. Barth. Hosp. Reports.*

lute necessity, and such seldom exists, for by restraining the movements of the joint by some leather, felt, or other light casing the foreign body may become fixed, and consequently innocuous. Indeed, by such treatment Hilton has shown (*Guy's Reports*, 1868) that these cartilages may become absorbed. He fixes the loose body by means of a pad and strapping at the most convenient spot, and places the limb upon a splint. By this practice pain is prevented; the pedunele of the cartilage cannot be stretched or the cartilage slip between the semi-flexed bones. In 1877 I thus treated a woman who had a loose cartilage the size of a large almond, and in three months, under observation, it gradually lessened until it disappeared. When inflammation of the joint follows one of the attacks of pain, it should be treated on ordinary principles. When, however, the cartilage by its presence produces such serious inconvenience as to destroy the value or use of the joint, whether from the frequency of the attacks, the amount of inflammation that follows, or the dread connected with the affection, some operative interference may be justifiable, and the cartilage should be removed by either direct or subcutaneous incision: no operation should be undertaken till all inflammatory action has ceased and the joint is in a quiescent state. With the view of removing the offending body by direct incision—a practice which has gained ground in recent times—a splint should be applied and worn for at least a week; the loose body should then, by manipulation or by such movement of the joint as the patient from experience knows will bring the cartilage under the surgeon's control, be brought up to one side of the joint (and in the knee its usual seat is on one side of the patella), where it may be fixed with the finger. The surgeon may then draw the skin over it to one side and cut down directly upon the cartilage, the incision being large enough to allow of its escape. The wound, having been well washed with an antiseptic lotion, should be closed by sutures dressed with iodoform or carbolic gauze, and the limb kept upon a splint till repair has been perfected.

The removal by subcutaneous incision consists in the fixing of the cartilage by means of a grooved or harpoon-shaped needle inserted into its substance through the skin; of, next, the introduction of a tenotomy knife beneath the skin down to the cartilage, and the division, by a free sweep of the knife, of all the subcutaneous tissues covering it in; then of the dislodgment of the cartilage by the application of strong digital pressure or tilting it by means of the grooved needle into the cellular tissue of the parts around, and the application of a pad of lint over the spot where the cartilage escaped from the joint; finally, absolute rest of the limb upon a splint must be subsequently enforced and an ice-bag applied over the joint. After this operation a small blister may be applied over the cartilage in the cellular tissue, Syme having found that by such means the foreign body becomes fixed in its new position and subsequently absorbed. To remove it by a subsequent operation is a recognized, though rarely a required, measure. Mr. W. J. Square of Plymouth adopts the indirect operation, but, instead of squeezing the cartilage completely through the subcutaneous wound, he is satisfied by simply pressing the foreign body into the subcutaneous opening and fixing it there by compress and strapping. At the Brit. Med. Assoc. for 1871 he related twenty-four successful cases. The subcutaneous operation has hitherto been considered the safer of the two described, but with our improved methods of treating wounds the operation by direct incision is said to be equally safe. We, however, want facts to establish this point.

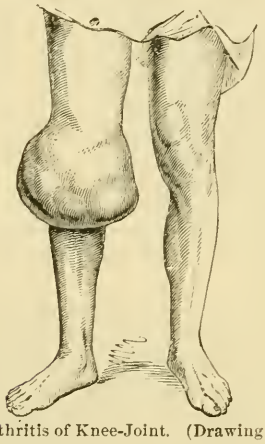
M. Larey's statistics (*Gaz. des Hôpitaux*, No. 67) fairly support the indirect method: Out of 129 cases operated upon by the direct method, 28 were fatal, and only 5 out of the 38 by the indirect. He concludes, after a careful analysis of cases, that the operation is a serious one when practised by direct incision and a difficult one by the subcutaneous method, while extraction is more dangerous than the persistence of the affection. He believes the operation is indicated by the complete mobility of the foreign body within the joint: the persistence of the accidents caused by its presence—viz., pain, arthritis, and lameness; the failure of acupressure and other means for fixing the position of the foreign body; and the free consent of the patient after having been made aware of its dangers.

RHEUMATIC OR CHRONIC OSTEO-ATHRITIS.

This affection, originally described by J. Haygarth (*Clinical History of the Nodosity of Joints*, 1813), and accurately depicted by Cruveilhier in his *Pathological Anatomy* (1813), is now a well-recognized affection, thanks to the labors of the late Dr. R. Adams of Dublin and his splendid monograph published in 1857, to Prof. Smith of Dublin, and Canton of London. It is chiefly seen in the middle-aged or the old, though occasionally

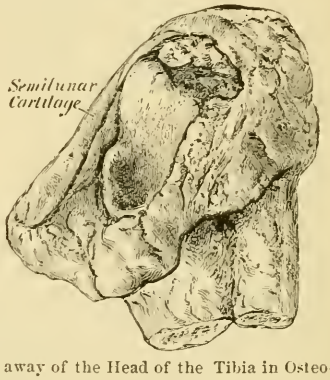
in young people. It may attack any joint, but is most common in the hip and shoulder, and generally comes on without any definite cause; yet in not a few I have known it follow directly upon some injury. A large number of cases put up as unreduced dislocations in the different museums are doubtless examples of this affection, the displacement of the head of the bones being the result of the disease. It is unfortunately called "rheumatic," although it has no apparent connection with what is generally called "rheumatism." It has probably acquired the name from its chief local symptom of aching pain in the joint, aggravated at night and in damp weather. The disease is at first associated with a dryness of the joint, but subsequently with excess of secretion, even to a great extent; with some thickening and expansion of the head of the bones entering into its formation, some eburnation of the articular lamella of bone with disappearance of its inter-articular cartilage after it has undergone the fibrous degeneration; and with what is still more peculiar

Fig. 644.



Osteo-Arthritis of Knee-Joint. (Drawing 33%.)

Fig. 645.



Wearing away of the Head of the Tibia in Osteo-Arthritis.

—the deposition of new crests (osteophytes, as they are called) or plates of bone around the margins of the articular facets and in the ligaments and synovial membrane. These crests often appear as ridges of bone which can readily be made out, and the plates may simulate a second patella when the knee is the joint involved. In the case from which Fig. 644 was taken all these conditions were readily distinguishable, the bones and synovial capsule being enormously enlarged; the ligaments were so stretched as to allow of some lateral movements in the joint, and the characteristic rough, crackling sensation which movement of the joint always gives was most marked.

In still more extreme or neglected cases the end of one indurated bone will grind away in time that of its contiguous bone, the condyle of the femur having in the case from which Fig. 645 was taken ground down the head of the tibia for at least an inch. The preparation was made from the amputated limb of a man æt. 36, the leg having been taken off at the knee-joint, because the limb was a flail and the joint threatened to become disorganized, and an excellent stump was left.

When the hip-joint is diseased, the head of the bone flattens down, the neck shortens, the cup of the acetabulum becomes saucer-like, and around its margin, as well as around that of the head of the femur, an irregular crust of bony outgrowths forms (Fig. 646); the cartilage likewise disappears, and the articular surface of the bones presents a dense eburnated appearance. In the knee-joint one or both of the condyles of the femur become elongated and expanded, the head of the tibia flattened, the patella enlarged, and *osteophytes* of variable forms and dimensions fringe the margins of the bones. The synovial membrane also will be thickened, and at a late stage of the affection expanded from effusion, the ligaments in this way becoming elongated and the joint dislocated. Adams's "additamentary bones," or new plates of bone of different sizes, are found within the synovial membrane, with probably some pedunculated bodies upon its inner surface.

In its early stage the disease is characterized by local pain, stiffness or rigidity of the joint, and local thickening and development of bony outgrowths, every movement of the joint giving rise to a characteristic crackling. In the later stage the same pain manifests itself with thickening, bony outgrowths, effusion, greater mobility, and even dislocation, and finally disorganization.

I have a lady under observation in whom this disease is so developed in both knee-

joints that the legs are as flails, the bones being enormously expanded and the joints distended, additamentary bones and osteophytes existing. She can stand only by means of artificial supports.

Treatment.—Little can be done by means of medicine to check the progress of this affection beyond attention to the general condition of the patient. In the iodide of

Fig. 646.

Changes in the Head and Neck of the Femur and in the Acetabulum in Osteo-Arthritis. (Preparation 1131[59], Guy's Hosp. Mus.)

Fig. 647.

External Appearances of the Ankle the Seat of this Disease.

potassium we possess a drug that certainly relieves pain, and also, I believe, retards the progress of the disease, the liquid extract of bark or other tonic being a valuable adjunct. When pain is severe, anodynes may be given, such as Dover's powder, or the bromide of potassium in doses of gr. x or gr. xv, this drug going well with the iodide. Professor Smith, who has paid so much attention to this disease, thinks well of an electuary of guaiacum, sulphur, the bitartrate and carbonate of potash, ginger, and rhubarb. Dr. Adams prescribes the diluted phosphoric acid. Warm bathing is of use, as are also the mineral springs of Germany. This disease, although locally a painful one, does not appear to have a fatal tendency, and unless very neglected rarely goes on to the disorganization of the joint. To maintain rest is not a recommendation to be attended to, as it tends to make the joint stiffen in the early stage of the affection without arresting its progress. In the more advanced stage, when "hydrops articuli" is present and the ligaments are so loose as to allow of the displacement of the joint, some mechanical appliance is called for, such as that afforded by simple strapping, or of some firm leather, felt, or other casing. In extreme cases excision or amputation may be required.

JOINT DISEASE ASSOCIATED WITH NERVOUS AFFECTIONS.

It has been known for some years that joint affections which simulate those called rheumatic have been met with in the subjects of diseases of the nerve centres, as well as in those who have had injuries to large nerve trunks. Indeed, from a recognition of this connection, Dr. J. K. Mitchell of Philadelphia in 1831 originated the theory that rheumatism was a spinal neurosis (*Amer. Journ. of Med. Science*, vol. viii.), and his argument had something in it. At the present day attention has been more particularly drawn to the connection by Charcot, Weir Mitchell, Clifford Allbutt, Buzzard, and others, and abundant evidence has been published to prove that in *tabes dorsalis* or *locomotor ataxia* there is a peculiar joint affection which approaches in some of its characters the osteo-arthritis just described, and yet in others differs from it in a very marked manner.

Symptoms.—It may appear early in the progress of the nerve disease—that is, with the characteristic "lightning pains"—or it may not show itself till these pains have become well marked. It usually first shows itself in one of the joints of the lower extremity.

The joint trouble begins with effusion into the joint, some swelling of the limb, and crackling of the joint on movement; but with these symptoms there are usually no increase in the temperature of the part, no pain, and no constitutional disturbances.

These symptoms may last for a few days or weeks and then disappear, and leave nothing behind except either some crackling of the articulation or a joint deformed from relaxation of its ligaments, or even dislocated. In extreme cases an articular facet of

bone becomes worn away and the head of the bone so altered in shape as to be unrecognizable. There may be false bodies to the joint, and in some cases osteophytic outgrowths from the articular surfaces; but these are never so well marked as they are in osteo-arthritis. There is never in this affection any eburnation of the articular surface of bone, so constant in osteo-arthritis.

At the same time there is a strong analogy between the two affections, and I am disposed to think that the differences between the two classes of cases are to be explained by the fact that in the case of osteo-arthritis the disease invades tissues in which nerve influence has its normal power, whereas in the other there is clearly a deficiency of such power.

In osteo-arthritis there is more new bone thrown out in the shape of osteophytes and plates than in the arthropathy of nervous disorders, because the action in the part is of a more sthenic type, and for the same reason, in the arthropathies now under consideration, the bone, from being ill-nourished and containing a diminished quantity of phosphate of lime and an excess of fat, is more readily worn down by attrition and made to disappear than in the osteo-arthritis of the more sthenic kind, in which the bone, from its hardness, becomes eburnated, and is only slowly ground down by attrition. More knowledge is, however, required respecting both these affections before they can find their right place in pathology.

Treatment.—Little more can be done in these cases than to keep the joint quiet by means of splints, and so to prevent movement, attrition, and displacement. In the state of joint effusion well-applied pressure is of use, and that applied by means of an elastic or rubber bandage over cotton-wool is to be recommended. When dislocation exists, some immovable casing to the joint is of use.

ACUTE BURSITIS AND SUPPURATION AROUND JOINTS.

I have placed these two headings together, as there is good reason to believe that suppuration about the cellular tissue external to a joint is most frequently the consequence of an acute inflammation of some superficial bursa, and that it is only in exceptional instances such a connection cannot be traced. Over the knee- and elbow-joints, where this suppuration is generally met with, some blow, fall, or punctured wound may originate an acute inflammation in the bursæ of these parts, while the thick integument covering them prevents the inflammatory products making their escape externally and favors their lateral extension: the abscess, consequently, in one case, after covering the knee, burrows backward into the popliteal space, or in the other comes forward in the arm into its flexure; more commonly, however, it shows itself as a painful phlegmonous inflammation over and around the patella or olecranon process. In some examples the suppuration is confined to the bursa, while in most the inflammation will be found to radiate from these well-known points. In children, however, the connection between the suppuration and bursitis is not so readily made out, and there can be little doubt that at times it does not exist.

The severe cases of suppuration around a joint are most frequently met with in children of delicate and feeble frames and in the badly fed, who are disposed to rapid extension of suppurative inflammation when started by any slight accident, blow, fall, or strain. When these large abscesses appear around the shoulder—a joint that is less liable to disease than any other—it has probably been caused by some strain or injury when the child is dragged along by a careless or violent companion, or it may be that the muscles of the parts are injured. At times it is the epiphysial cartilage placed between the epiphysis and the shaft of the humerus which has suffered.

Diagnosis.—The diagnosis of these cases of suppuration external to the joint is not difficult. On examination it will be seen that the swelling is external to the joint, covering in the well-known points of bone; in the knee the soft parts probably will be raised from the patella, and fluctuation will be felt above and around it. There will be much local pain, but not so much constitutional disturbance as would exist with a suppurating joint; the joint, moreover, will be capable of some amount of movement without pain—a condition which would be impossible if the seat of the disease were in and not around it.

Treatment.—There is only one form of treatment on which reliance can be placed in these cases, and this consists in giving free exit to the pus. A free incision, consequently, should be made into the abscess over the seat of the bursa as soon as any pus can be detected. The limb should be raised, the joint preserved at rest by splints, and warm-water dressing or a poultice applied; and the joint should be kept absolutely quiet

till repair has been completed. When the powers of the patient are feeble, tonics should be given. When the abscess is not opened early, it may open into the joint and produce an acute suppuration. I have known this happen in the knee with a fatal result. In the knee it is often necessary to make a free incision on either side of the joint, as well as over the patella, in order to prevent burrowing.

CHAPTER XXXIII.

DISEASES OF THE BONES.

General Remarks.

In a pathological sense diseases of the bone are identical with those of other tissues, while such differences as exist are due to their anatomical and physiological peculiarities, diseased action, under all circumstances, being materially modified by texture. In the bones diseased action is thus modified by the presence of the inorganic material which they contain, two-thirds of their constituents being earthy and one-third animal. This animal texture includes a fibrous periosteal membrane with cellular tissue beneath, as well as a finer endosteal membrane which lines the medullary canal. These two membranes are intimately connected together by delicate vascular and membranous links permeating the Haversian canals and canaliculi of the bone itself. The *exterior* of the bone is dense, and derives most of its nourishment from vessels ramifying in the periosteum; the *interior* of the bone is porous or cancellated, and derives its supply of blood from a distinct nutrient artery which runs in the endosteum; while the capillaries of both anastomose freely through the bone canals. The long bones also are built up of shafts (diaphyses) and epiphyses, the epiphyses being distinct from the shafts during the early years of life and having their own vascular supply. The shafts and epiphyses are connected together by means of a layer of epiphysial cartilage, through which, as proved by Prof. Humphry, the shafts mainly grow, though interstitial expansion has an influence in bone as in other parts. The epiphyses themselves are covered with articular cartilage that derives its nutritive supply from them. These anatomical points thus briefly sketched are important to remember when the pathological are considered, as most of the peculiarities of bone disease are explicable by them. Thus, when a bone is inflamed, it can be so only through its soft tissues, its inorganic matter being affected secondarily. The periosteal and endosteal membranes being intimately connected, inflammation originating in one is very liable to extend to the other; and in proportion to the nature or amount of this extension will the inflammation be periosteal or endosteal and the affection either periostitis or ostitis.

In long bones, when disease attacks the shaft, it may become arrested by the epiphysis or epiphysial cartilage, the articular ends of the bones, and consequently the joints, escaping. In periostitis, however, such a result is not always secured, for the synovial membrane of a joint, in a clinical point of view, may be regarded as a continuation of the periosteum, and pus beneath this membrane may burrow into the neighboring articulation, or the inflammation may spread by continuity. When the disease attacks the epiphysis, the inflammation may spread into the joint.

With these remarks the diseases of bones may be considered, dividing them into the inflammatory affections, tumors of bone, atrophy, hypertrophy, rickets, and mollities ossium.

INFLAMMATION OF BONE

may be divided into the *acute* and the *chronic*.

The acute may be idiopathic or the result of some injury, the division of a bone by operation, or a compound fracture; it may end in local abscess of bone, in diffused suppuration, or in the more or less complete death of the bone. When originating in the periosteum and not wholly involving the endosteum or medullary membrane, the outer surface of the bone alone may die; when originating in the endosteum and not wholly

involving the periosteum, the inner portion of the bone may die and the shell escape, the whole bone dying when both membranes have been equally involved, whether commencing in one or the other. The extent and the depth of the destruction of bone, or its "necrosis," are determined by the extent and intensity of the inflammatory action and the degree in which the membranes covering and lining the bone have been involved. Thus, on the one hand, the superficial necrosis of the frontal bone of a child may ensue after its exposure from a lacerated wound caused by the gnawing of a ferret (*vide* Fig. 648), in another case a large thin shell of bone may exfoliate from the tibia after an acute periostitis (Fig. 649), in both of these cases the life of the bone having been sacrificed

FIG. 648.

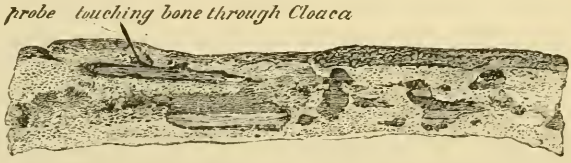
Superficial Necrosis of Frontal Bone following Wound caused by the Gnawing of a Ferret. (Delsey W——, æt. 7 months, June, 1874.)

FIG. 649.

Shell of Bone Exfoliated as a Result of Acute Periostitis. (Periosteal Necrosis.)

through the death of the periosteum alone. Fig. 650 represents a sequestrum the result of an acute endostitis, osteomyelitis, or ostitis (for all these terms are synonymous) surrounded by a reparative shell of bone newly formed by the uninjured periosteum; while

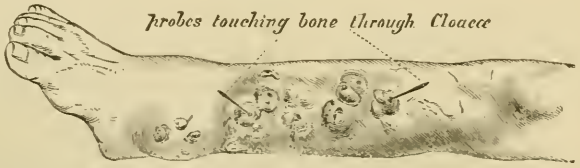
FIG. 650.



Death of Bone the Result of Acute Ostitis, the Sequestrum, composed of the Shaft of the Tibia, being surrounded by Shell of New Bone.

Fig. 651 illustrates the appearance of the limb so affected, taken from life, with the sinuses open leading from the surface of the limb through the soft parts of the shell of

FIG. 651.

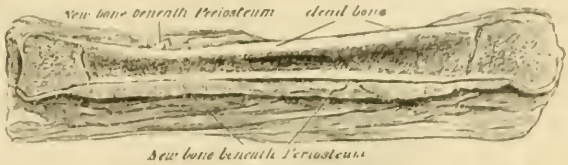


External Appearance of Limb the Seat of Acute Necrosis of the Shaft of the Tibia, with Cloacæ leading down to Dead Bone.

new bone to the sequestrum. Fig. 652 represents a section of a bone which died, nearly as a whole, from inflammation of both membranes, and upon the upper surface of which no new bone formed, the periosteum having been completely destroyed, although at the lower part, where the membrane was sound, bone has been renewed.

In all these cases the inflamed bone died wholly or in part from an acute inflammation, the bone by the inflammation having been deprived of its vascular supply through a blocking of its capillaries, its death resulting from blood stasis. These changes, however, do not always ensue, for the acute inflammation in some cases may terminate in an acute abscess of bone with or without necrosis, and in other cases in acute abscesses. I have in the tibia met with three centres of suppuration the result of acute inflammation. When acute inflammation attacks an epiphysis, the same pathological changes ensue. The whole epiphysis may die and be cast off, or it may be the seat of an abscess or of a local necrosis; and when the local necrosis is confined to the articular lamella of bone, the joint will become involved, as well illustrated in Fig. 653. In Fig. 639 the head and neck of the radius necrosed and gave rise to suppuration.

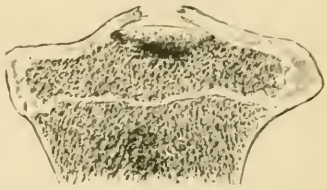
Fig. 652.



Necrosis of the shaft of the Tibia the Result of Acute Ostitis and Periostitis. (Prep. 1215[68].)

In chronic inflammation of the articular extremities of the long or spongy bones other changes occur. They may be described as follows, quoting my own words written in 1859 (on diseases of joints): In the earliest condition simple vascularity will be the principal morbid appearance, the cancelli containing more serum than natural; but as the disease advances the bone becomes larger than natural, this enlargement in some cases being very great. Upon making a section of the bone the saw will break through its structure more easily than in a healthy specimen, its earthy constituents having diminished; and on comparing the structure of the diseased with a healthy bone it will be observed that its cancelli are much enlarged and the columns radiate from the shaft in a palm-like fashion, as if they had been spread out from downward pressure. When the inflammatory process is of a tolerably healthy character, parts of the bone will appear denser and more indurated than the remainder, from the organization of the inflammatory deposit, this deposit in bone always becoming osseous; frequently, however, the death of the bone, with a small or large sequestrum or a local or diffused abscess, is the result. If the denser portion of bone forming the shell is examined, it will be found thinner than natural and appear as if it had been dilated, in some cases crackling on firm pressure. Where the articular extremity joins the shaft some new bone may be detected, thrown out, as it were to support its dilated body. The articulating surfaces of the bones will in some parts appear more vascular than normal, whilst in other more advanced cases portions having been thrown off like a slough will be found loose and lying in the joint, the denser portions of bone, as a result of articular ostitis, dying more rapidly than the cancellated.

Fig. 653.



Necrosis of the Articular Lamella of Bone, with Degeneration of Cartilage covering it in.

The cartilages at the same time undergo degenerative changes and separate from their bony attachments more or less rapidly, in some cases being cast off as a slough or shed as a nail or cuticle. Under these circumstances joint disease occurs.

In chronic inflammation of the shafts of bones changes similar to these are equally manifest, the bone in the early stage first expanding, and in subjects of better power subsequently thickening, from the organization of the inflammatory exudation, the bones thus becoming solid and dense and the subject of a condition known as sclerosis (Fig. 654).

In cases of inflammation of bone when the periosteum is not morbidly involved a layer of new tissue secreted from the periosteum is poured out upon the bone, and at first is soft and fibrinous, and subsequently hard and osseous, the new material being reparative in its nature and that from which the new bone will be formed. It may be only a few lines in thickness, though at times it is even half an inch (Fig. 656); and before it becomes osseous it can readily be peeled off the bone by means of the handle of a scalpel or periosteal elevator. It is to this tissue M. Ollier alludes when he recommends the sub-periosteal resection of the shaft or articular ends of bone, for it is mainly upon such that the regeneration of a bone or part of a bone depends. Changes analogous to those described as going on in the periosteum occur in the endosteum or medullary membrane of the bones, although not so well seen. The products, therefore, of a periostitis

or endostitis vary with the character and intensity of the inflammatory process, precisely in the same way and under the same conditions as the products of inflammation vary in the softer tissues. In very intense inflammation the death of the inflamed part is the result—death of the periosteum with the bone depending upon it for its nourishment, of the endosteum with its bony fabric, or of the whole bone when both membranes are

Fig. 654.

Sclerosis of Bone the Result of Chronic Inflammation. (From Prep. Guy's Mus.)

equally involved. When the bone does not die in mass, it may in detail, and as a result of the inflammation local abscess of bone or diffused suppuration may ensue, with or without necrosis or a sequestrum; when the suppuration is around the bone, it is seen as a periosteal abscess—a condition which is mostly followed by a more or less extensive necrosis.

The character of the pus in these cases of bone abscess is of diagnostic importance. Pus the result of periostitis differs in no respect from that found in other tissues, but pus the result of endostitis, ostitis, and osteo-myelitis is freely mixed with oil globules. In a striking case of this latter affection in a girl æt. 10, which was under my care, where a free incision was made down to the tibia, the surface of the fluid evacuated was covered with oil cells. Roser has made a like observation.

Acute Inflammation of Bone,

whether periosteal or endosteal, is chiefly found during the growing period of bone, before puberty, and is a very grave affection. It occurs in the feeble and cachectic and in those termed scrofulous, in the shafts of the long bones as well as in the epiphysis, and in such as are most exposed, as the tibia and ulna, although it is almost as frequently seen in the femur. The bones of the upper are probably more rarely affected than those of the lower extremity. It is often the result of some local injury or exposure, though as often as not no such exciting cause can be made out.

Symptoms.—The disease is generally ushered in with a deep aching pain in the bone, with local tenderness, often a rigor, followed by intense constitutional disturbance and increase of temperature. The pain in the limb is speedily followed by swelling, which at first is deeply placed and not marked by any external evidence of inflammation, such as redness; as the swelling increases the soft parts covering it become tense and œdematous and the veins of the part look full, such symptoms indicating deep-seated obstruction, while any attempt at movement or pressure causes suffering. When the disease is situated in the articular end of a bone, it is constantly mistaken for rheumatic fever.

If the disease is *periosteal* in its origin, the skin soon becomes involved and local redness appears, the slightest touch exciting pain. If *endosteal* at the onset, gentle manipulation will be allowed, and many days will pass before redness and other external signs of inflammation show themselves, these appearing only when the disease has spread to the periosteum and through it to the soft parts around. When suppuration ensues, the skin, from being tense and œdematous, becomes inflamed, and the constitutional disturbance worse; rigors become more frequent, pain is more intense; sleeplessness, and probably delirium, with a feeble pulse, appear; and unless relief be afforded by a free incision down to the bone, death by exhaustion, and probably by blood-poisoning, is apt to occur, since the connection between acute inflammation of bone and septicæmia is very close. (*Vide* Chapter I.)

When the inflammation is essentially *periosteal*, more or less well-formed pus mixed with blood will be effused, though in feeble subjects it may be only a blood-stained serum containing lymph. In some of the worst cases of this disease I have seen this effusion was very copious.

Endostitis is particularly prone to be accompanied by blood-poisoning; it is, therefore, a far more serious disease than periostitis, whether as a primary affection or as consequent upon the latter.

Acute periostitis, ostitis, or endostitis may attack the cranial, carpal, and tarsal bones, the shafts, articular ends of bones, or epiphyses; and, according to its seat or extent, it may terminate in recovery or in the complete death of either the centre or the shell of

bone. The best instance of death of the bone from periosteal inflammation is seen in the ungual phalanx of the finger, the bone dying as a whole some five or six weeks after the first onset of the inflammation, without any attempt at its re-formation. Such cases are, generally, but wrongly, looked upon as *whitlows*. Of the tarsal bones, it is most common in the os calcis, large sequestra being often met with in this bone; periosteal necrosis is, however, comparatively rare in the calcis, except as a result of injury to its tuberosity.

When this disease attacks the articular ends of the bones, acute joint mischief is the general result; and when it follows the division of bone, by either amputation or resection or after compound fracture, gunshot or otherwise, it is a common cause of death and too frequently is the precursor of septicæmia. Sir Joseph Fayrer, who has drawn attention to this fact in his *Annals of Med. Science* (1865), looks upon the prominent fungous mass of granulations that is often seen covering the end of an amputated bone as indicative of the affection, and believes that the facility with which the surgeon passes a probe well into the medullary cavity through these granulations establishes the diagnosis. He gives the general symptoms as pain in the part, œdema, and swelling extending down the limb, general fever, with quick pulse and increased temperature, and more especially the recession of the soft parts, including the periosteum, from the bone, which is then left denuded at the bottom of the wound.

Jules Roux of Toulon first drew attention to this affection, and gave it the name "osteo-myelite." It is, however, essentially an endostitis, only of traumatic origin.

Treatment.—In all cases of acute inflammation of bone or periosteum, in which of necessity there must be effusion beneath the dense fibrous periosteal layer, there is no treatment equal to that of a free incision down to the bone; and if the disease is not arrested or modified by this practice, immense relief to pain is rapidly afforded. There is good reason to believe, too, that by such treatment the disease is often limited, and even arrested, as well as the death of the bone averted; for bone, like other tissue, is very prone to die when subjected to the compressing influence of a confined effusion. When the upper part of the shaft or the articular end of a bone is the seat of disease, this practice is very important.

Before making an incision there is no need for the surgeon to wait for the formation of pus, as to do this is generally to wait too long. The object of the incision is to relieve tension; consequently, it should be carried out as soon as tension clearly exists. In cases of acute disease of the tibia, with severe local pain and constitutional disturbance, I have opened the periosteum on the third or fourth day, before any external evidences of inflammation showed themselves, except turgid veins and bone enlargement. The incision gave vent to blood-stained serum, but it was followed by immediate relief to all local and constitutional disturbance and by a rapid recovery. If the incision does not save the life of the bone, it relieves symptoms, and, what is more, it may limit the disease by preventing the pus from burrowing beneath the periosteum covering the shaft of the bone into the neighboring joint. This liability to joint complication is, indeed, one of the strongest arguments in favor of the practice. The limb, at the same time, should be elevated and hot fomentations applied; pain should be relieved by opium, morphia, chloral, or any other sedative, and the general powers kept up by abundance of nutritious food, such as milk; while stimulants should be cautiously administered.

When the inflammation ends in necrosis, it requires to be treated according to the mode to be referred to in a later page.

Occasionally, as an effect of acute inflammation of the periosteum, much blood is effused between the membrane and the bone. I believe this result to be mechanical and due to the rapid separation of the periosteum: it is met with only in acute cases.

Acute Abscess in Bone.

Abscess in bone is the result of a local inflammation, and may or may not be associated with the death of a small piece of bone. In some cases it is acute, but more generally chronic.

In the *acute* some necrosis is generally associated with it; in the *chronic* such an association is more rare.

Not long ago I treated a boy æt. 17 who after intense pain in the head of his tibia for three days had local swelling and severe constitutional disturbance that had been regarded as due to rheumatism. At the end of a month, when I saw him, I made a free incision down to the bone, to relieve pain and give vent to any pus that might have found its way externally. A week later pus appeared, evidently from the bone, for a probe could be

passed through the wound into a cavity. Two weeks later, or six weeks from the commencement of the symptoms, I enlarged my opening, and through the aperture in the head of the bone from which the pus had flowed I removed three pieces of bone, together making one the size of a nut, which rested in a cavity lined with velvety granulations such as are so characteristic of an abscess. A complete recovery ensued. In another boy, æt. 16, in which severe local and constitutional symptoms had arisen early, I removed a similar piece of bone from a like cavity in the end of the radius, and with a similar good result. In both cases acute inflammation of bone had ended in the formation of a local abscess with circumscribed necrosis, and recovery rapidly followed the surgical treatment.

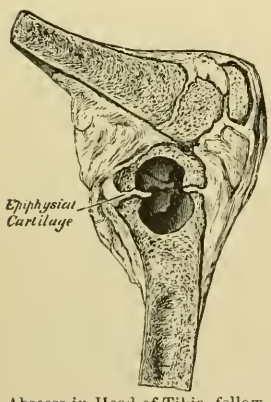
A few years ago a child was brought to me who had received, when asleep, an injury to the tibia, from a playfellow having attempted to drive a pin into the bone. Nothing beyond some slight local pain had followed the injury for a few days, when severe pain and swelling appeared, with fever, etc. I cut down upon the part with a view of giving relief, when the point of my knife went with a crackle through a thin layer of bone into a cavity, which gave vent to a teaspoonful or more of pus. Immediate relief followed the operation, and a good recovery took place.

These three cases suffice to illustrate the fact that acute abscess in bone is met with, and to show its symptoms and treatment.

Chronic Abscess in Bone.

In 1773, William Broomfield, surgeon to St. George's Hospital, in his *Chirurgical Observations*, wrote: "Whenever a patient complains of a dull, heavy pain deeply situated in the bone, possibly consequent to a violent blow received in the part some time before, and, though at the time the patient complains of this uneasiness within the bone, the integuments shall appear perfectly sound and the bone itself not in the least injured, *we have great reason to suspect an abscess in the medulla.*" In 1824, Sir B. Brodie amputated a limb for incurable pain in the tibia; and in this case—which Sir W. Fergusson has described "as one of the beacon-lights of surgery never to be forgotten"—"the lower end of the tibia is enlarged and the surface presents marks of great vascularity; the bone in the preparation is divided longitudinally, and just above the articulating surface there is a cavity as large as a small chestnut. This cavity was filled with dark-colored pus. The inner surface of it is smooth. The bone immediately surrounding it is harder than natural."

Fig. 655.



Abscess in Head of Tibia, followed by Disorganization and Dislocation of the Joint. (Prep. Guy's Hosp. Mus, 124^{50}.)

In these two extracts, written at an interval of fifty years, are embodied the clinical and pathological facts connected with this subject which are now recognized by surgeons.

Sir B. Brodie in 1846 published a valuable paper on this subject, and to him, oddly enough, the full credit of recognizing these cases has been wrongly attributed. He probably first heard of them from John Hunter.

This chronic abscess is generally met with in the articular ends of bones—that is, in their cancellous tissue—more particularly in the two ends of the tibia. I have, however, seen it in the condyle of the femur and the humerus and in the shafts of the ulna, radius, and tibia. It may also occur in any bone. In Fig. 655 the cavity of such an abscess is illustrated, and in Fig. 634 is seen its opening into the joint. The history of these cases is generally obscure, an injury at times being its assigned cause.

Symptoms.—The most characteristic symptoms are a fixed aching pain in the part, "the pain being a dull one, rather tending to produce sickness than to rouse" (John Hunter); exacerbations occur in its progress, when the pain becomes acute, fixed, and of a burning pulsative kind—"like the falling of drops of molten lead," as a patient once described it to me; there will likewise be local circumscribed tenderness or pain on firm pressure, with probably some evident enlargement of bone and the sense of local heat.

In more advanced cases the soft parts over the bone will be œdematous, and on firm pressure over the painful spot a sensation of yielding will be given to the finger. In still more neglected cases the abscess may make its way into a joint, while under fortunate circumstances it may advance forward and discharge itself externally.

Treatment.—"Abscess in bone may find its way to the surface," but "the crown of

the trephine is often necessary in order to get at the seat of abscess," said John Hunter in 1787 (MS. lectures). At the present day a like treatment is to be advised, as nothing less than the opening of the abscess in the bone is of any use; and this is usually done by means of a small trephine. The point to be selected for the operation is the painful spot, which should be marked before the patient is anæstheticized; the soft parts should then be divided by a crucial incision and turned back and the bone itself freely perforated, with the periosteum covering it. When the instrument has opened the abscess, pus will well up at once; the ring of bone raised by the elevator ought then to be taken away; the cavity, which is generally lined with smooth, velvety granulations, is rarely very large and the quantity of pus seldom above a drachm, although sometimes there may be more. After the operation the parts have only to be left alone to heal, recovery being very general.

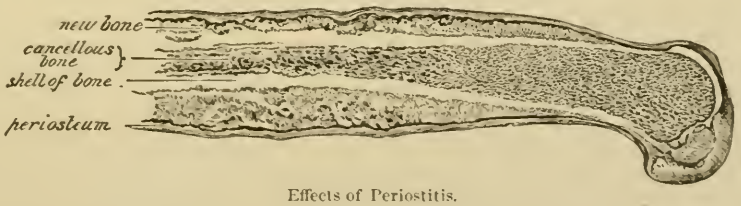
It is not always necessary, however, to trephine a bone, as a less severe operation is at times all that is required, and that is its simple puncture by means of a drill; when the seat of the abscess is not very accurately defined, the drill is probably the better instrument to use. In a striking case I had in the spring of 1870 I carried out this operation and punctured the head of the tibia of a man who had all the external evidence of local ostitis and suppuration, such as pain, bone expansion, etc. I cut down upon the painful expanded part and made two punctures with a drill, one of which clearly went into a cavity in the bone, as evinced by the sudden loss of resistance. No pus, however, was seen to well up in the wound at the time, though soon after the operation a free discharge took place. The operation was followed by complete relief from all pain, and in a month the man left Guy's quite restored, and three months later he remained so. More recently I arrested disease in the femur of a boy æt. 18 by trephining the trochanter major and puncturing the bone with a drill through the opening.

This operation of drilling the bone seems to be good either for supposed suppuration or for chronic ostitis. It is less formidable than trephining and may be done in cases where the latter is inapplicable or not to be entertained; indeed, the two means may be employed together when the trephine has failed to open the abscess. Holmes's suggestion is good—viz., to pierce the walls of the trephine-hole in several directions with a sharp-pointed instrument, in order to remove the bone freely with a chisel if a drop of pus follow any of these punctures.

Chronic Periostitis and Endostitis.

Chronic periostitis and *ostitis* are very common affections, more particularly involving the shafts of the long bones. These affections may be modified by syphilis, scrofula, or rheumatism and may originate from some local cause or injury, but in all their course is the same, the disease varying only in the rapidity of its progress, extent of its influence, and results. In one case complete recovery may take place, the effusion being reabsorbed; in another the effusion may become organized as a superficial node or bony outgrowth (Fig. 656) or as an enlarged, elongated area of dense bone (Fig. 654). In excep-

Fig. 656.



Effects of Periostitis.

tional cases local suppuration may occur, giving rise to a chronic periosteal or endosteal abscess; in a large proportion of instances the bone dies, and thus gives rise to local *necrosis*; whilst in some few the bone, either upon its surface or upon its interior, undergoes a chronic disintegrating process known as *caries*.

In local periostitis a small portion of bone alone may die, and, as Sir James Paget has shown (*Clin. Soc. Trans.*, 1870), remain quiescent under a puffy or suppurating swelling.

Symptoms.—The symptoms of chronic periostitis and ostitis (endostitis) are in their nature very similar to, though less severe than, those of the acute, the most constant being a dull, aching pain in the part, of a persistent kind, aggravated at intervals and

on hanging down the limb, the pain being almost always worse at night, more particularly in syphilitic affections. The constitutional symptoms vary according to the severity of the local condition, febrile disturbance and intensity of local action running hand in hand.

In *periostitis* the pain is generally local and attended with swelling at an early period of the affection—indeed, within a few days of its onset. In *endostitis* the pain is generally more diffused through the whole bone, and will continue for weeks or months without any external evidence of enlargement, being too often regarded as "rheumatic" or "growing pains." In *periostitis* tenderness on manipulation is an early and constant symptom. In *endostitis* the bone may be manipulated with gentleness without exciting pain; firm pressure, however, almost always causes suffering. In *periostitis* the enlargement generally shows itself as a bossy or undulatory swelling on the surface of the bone, with one, two, or more nodes upon the bone; syphilitic periostitis is generally multiple and undulatory, traumatic and other forms of nodes usually single. In *endostitis* the enlargement appears as a general expansion of the bone in all directions; in rare cases, as a distinct *elongation*. In *periostitis*, when suppuration is about to take place, external evidence will appear in the form of increased swelling and tenderness, while redness of the skin, œdema of the tissues covering in the node, and fluctuation will be present. In *endostitis* terminating in abscess there will be a great aggravation of local pain, with constitutional disturbance, and often rigors; and when œdema of the soft parts over the bone and external evidence of inflammation appear, the abscess is making its way externally through the periosteum. (*Vide* "Abscess in Bone.")

In necrosis of a long bone the result of periostitis and endostitis by extension the hope of a new bone being formed is forlorn, as the periosteum—the chief bone-forming membrane—has been destroyed, while in the necrosis of endostitis there is every hope of a complete restoration of the bone through its periosteal covering taking place on the removal of the dead portion or sequestrum.

In *necrosis of the skull*, which is always periosteal, no new bone is formed, as the periosteum is destroyed. When following an injury to the skull, it is preceded by "the puffy tumor of Pott." In syphilis it follows a suppurating node.

In a rare, if not unique, preparation (Guy's Museum) of necrosis after amputation, taken from a patient of my own, the end of the divided femur died, and at a later period the periosteal sheath of new bone that formed around it also died, one sequestrum being found within the other on their withdrawal from the stump.

Treatment.—In *chronic periostitis*, when suppuration does not take place, fomentations, with the elevation of the limb, sedatives to allay pain, and the internal use of the iodide or bromide of potassium, with or without tonics, according to the special requirements of the patient, are the most efficient means. In still more chronic cases the use of a blister or the repeated application of the compound tincture of iodine is of value. If rheumatism seem to influence the morbid action, colchicum has a beneficial tendency. When nocturnal pain is great, besides the internal administration of opium or other sedatives, the external application of belladonna certainly gives relief. When pain is severe and unrelieved by such treatment, a subcutaneous section of the periosteum with a tenotomy knife is advisable. When suppuration threatens, the warmth of a poultice or hot fomentation, with or without the application of leeches, may sometimes arrest it; a blister at times seems to check its progress. When pus has formed, it is wise, as a rule, to let it out, but the surgeon should be in no hurry to do this unless the pain is great and the abscess has a disposition to spread, as pus may be reabsorbed, and opening a periosteal abscess renders bone exfoliation more probable.

Chronic ostitis is an affection most troublesome to treat with any effect, and the same means that have been recommended for periostitis may be tried in this. In a general way, however, they do little more than give relief and have but slight effect on the progress of the disease, it being far too common for a bone in a state of chronic inflammation to become necrosed. When treated early, however, success is not unfrequent. When the disease is steadily progressing and remedies appear to have no influence on its progress, the operation of drilling the bone in one or more points, according to the extent of the disease, is an operation to be recommended; when this fails, that of trephining may be employed; for if taking away a piece of bone or drilling it does not arrest the disease—which it undoubtedly often does—it at any rate gives relief to local pain. Pain in endostitis or periostitis is due to tension caused by pent-up inflammatory effusion, whether fibrinous, purulent, or serous, and relief can be afforded only by its removal. When a new growth, cystic or otherwise, occupies the centre of a bone, a like pain is, however, experienced.

NECROSIS

means "the death of bone," and it is as a rule the result of an acute periostitis or endostitis, the chronic action being shown in the process of exfoliation—*i. e.*, in the separation of the dead from the living bone; for in this process a considerable time is often expended, no definite period having been hitherto recognized, as the rate of progress differs in every case. It may be of the shaft of a bone or of an epiphysis; it may be of the shell or compact tissue, of the inside or cancellous tissue, or of both combined. It may occur idiopathically without known cause or as the result of fever, injury from sprain, concussion, contusion, fracture, or gunshot wound. I have already related a case in which local necrosis of the articular extremity of the tibia took place in six weeks, and it is well known that phalanges necrose and exfoliate in five or six; in fact, in acute necrosis, a month or six weeks is full time for bone to die and be thrown off. This process is, however, at times very chronic. In the necrosis of the lower jaw from phosphorus the same truth is exemplified.

The process of exfoliation is a very beautiful one, and is the same in bone as in the soft parts, only slower.

"When a portion of bone is to die," writes Holmes in an admirable article in his *System* (vol. ii. 3d ed. p. 294), "the first phenomenon is the cessation of circulation in it. This leaves it hard, white, and sonorous when struck. It does not bleed when exposed or cut into, and is insensible. Occasionally, when the dead bone is exposed to the air and acted on by the presence of putrid pus, its color becomes nearly or quite black; large surfaces of hard black necrosed bone are sometimes left exposed by the sloughing of the skin over the tibia. The dead bone at first retains its connection to the bone around, as well as to the periosteum or whatever part of the nutrient membrane may belong to it; but the presence of a dead part is never long tolerated by the living tissues, and accordingly the processes which are to eliminate it soon become perceptible in both these structures. The periosteum or medullary membrane, as the case may be, separates from the dead bone and becomes inflamed; a quantity of ossific deposit (more or less, according to circumstances) is poured out between it and the dead bone, and this deposit soon becomes converted into new bone, forming a sheath over the dead portion, by which the latter is enclosed, or *invaginated*, as the technical term is. The dead part is now called a *sequestrum*—a name only properly applied to it when loose and invaginated, though often incorrectly used of any piece of dead bone. While this sheath is being formed from the membrane coating the dead bone changes are going on in the living bone to which it was attached. When the latter has been previously diseased—*i. e.*, when the necrosis has been of inflammatory origin—the inflammatory deposit which surrounds the sequestrum softens, pus is formed, and a groove of ulceration is produced at the expense of the circle of inflamed bone which forms the margin of the sequestrum. If the surrounding bone has been previously healthy, the sequestrum acts as an irritant upon it, setting up first inflammation and thickening to a variable distance, and then ulceration. Thus a groove is traced round the sequestrum, and the formation of the groove is accompanied by suppuration, 'the pus containing much earthy matter from the disintegrated tissue, B. B. Cooper stating two and a half per cent. of phosphate of lime.' The pus formed in the neighborhood of the dead parts makes its way to the nearest surface, and in so doing interrupts the formation of the periosteal sheath, leaving sinuses or *cloacæ* passing through this sheath from the sequestrum to the surface of the body, or sometimes into a neighboring joint or serous cavity. The presence of such sinuses leading through the shell of bone to hard, smooth, sonorous bone at the bottom of the cavity is the distinguishing mark of necrosis" (Fig. 651).

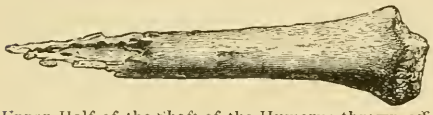
Where the periosteum has been destroyed, no investing sheath of bone will exist to interfere with the separation and casting off of the sequestrum (Fig. 652); where it is nearly perfect, the shell of new bone will be complete (Fig. 650). Under these circumstances the casing thickens and becomes dense. The amount of thickening around the sequestrum depends much upon the extent of new bone poured out by the periosteum and the duration of the process; its density also turns upon the length of time the sequestrum has been invaginated and the character of the inflammation. The bony shell in its early condition is soft and readily cut, broken down, or peeled off; in its later stages it becomes almost as hard as ivory and is most difficult to cut. To reach the sequestrum in the thigh I have cut through a bony sheath upward of an inch in thickness.

The whole shaft or any portion of a long bone may become necrosed, the epiphyses often saving the joints (Fig. 652), but, as a rule, some portion of the shaft remains

attached to one or other of the epiphyses. Occasionally the epiphyses themselves are the seat of necrosis. In the tarsal bones, during infant life, the ossific centre of the bones may die and exfoliate. There is also good reason to believe that necrosis of the shaft of a bone often originates after a sprain from inflammation started by the injury in the epiphysial cartilage connecting it with the epiphysis. The subperiosteal sheath is never seen in necrosis of the skull or in short cancellous bones.

When the cloacæ of the bone case are large and fortunately placed toward the end of the sequestrum, natural efforts may be sufficient of themselves to get rid of the foreign body, the granulations filling the cavity gradually pressing upon the dead bone and mechanically extruding it from its bed. In this way large masses of bone are sometimes discharged by natural processes. After amputation this result is frequently seen. Some years ago I saw with Mr. Cock and Dr. Iliff of Kennington a case in which the upper part of the shaft of the humerus, which had separated at its upper epiphysis, was gradually pressed out from below through the deltoid muscle and projected outside the acromion process for about an inch; Mr. Cock had only to complete the process which nature had so well commenced and draw out the bone, which was four inches long (Fig. 657).

Fig. 657.



Upper Half of the Shaft of the Humerus thrown off at its Junction with the Upper Epiphysis by Natural Processes. (Prep. 1104[20].)

Every surgeon is familiar with a somewhat similar act in other cases where large pieces of bone, and far more frequently small ones, are sometimes discharged by natural processes, but such successful natural efforts are rare in comparison with the failures; surgical art is demanded, as a rule, to assist in a cure.

When the dead bone has been shed and the sequestrum extruded by natural efforts or removed by surgical skill, the bone granulates, and thus heals. When this process takes place upon its surface, the steps are very visible; and when the sequestrum has been removed from a cavity, the same process goes on, but with it the gradual contraction of the periosteal shell of new bone that surrounds the sequestrum. A bone in this way is re-formed and repaired.

Treatment.—When the presence of dead bone has been made out, its removal is the only sound practice, since the longer it is left in its cavity, the thicker and denser will become the periosteal bony sheath; consequently, the probabilities of a natural cure are lessened and the difficulties of a surgical operation greatly increased. The sequestrum, however, cannot be taken away until it has been thrown off or loosened from the living tissues, although as soon as this result has been effected the sooner the operation for its removal is performed, the better. To interfere too soon before this process has been completed is sometimes injurious and always futile; to wait too long is simply to add to the difficulties of the case and to postpone recovery. Bones that are not loose may, however, often be detached by a good twist with a pair of forceps or raised by an elevator.

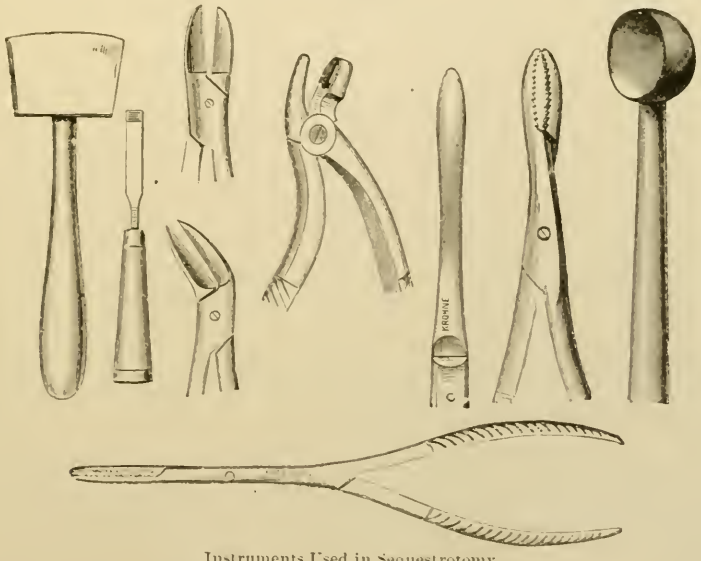
When the dead bone is found to be loose by means of a probe, by being made to move in its sheath, there should be no hesitation on the part of the surgeon as to interfering, though when this movement cannot be made out the same treatment may be justifiable, as the sequestrum may be so tightly impacted or shut in by granulations as to be immovable, though still separated. Under these circumstances the history of the case, and more particularly the duration of the disease, will be of great help as a guide; for if many months have passed since the inflammation that killed the bone set in, the probabilities of the sequestrum being loose are great, as most sequestra are shed in four, five, to ten months. I have seen a sequestrum in acute disease thrown off in six weeks, and have removed a large portion of the shaft of the tibia three months after the first onset of the symptoms, while, on the other hand, the dead bone may be found fixed at a far more distant date than that named. All know that a necrosed phalanx is generally loose and ready for removal at the end of five weeks, and in most cases the surgeon is justified in performing the operation for necrosis (sequestrotomy) within the year. English surgeons, as a rule, are disposed to wait till the evidence of the sequestrum being quite loose is clearly marked, whilst many continental surgeons, and particularly the German, excise diseased bone within three months of the first manifestation of disease by what is called a subperiosteal operation—that is, the peeling off of the periosteum and the resection of the shaft of inflamed, dying, or dead bone. But in doing this, as nature has not yet indicated the limit to the disease or separated the dead from the living bone, much good bone

must of necessity be often removed with the diseased or much of the diseased bone left behind, both of which are undesirable objects. In English practice the cure is often too long postponed, and the difficulties of the operation are increased. In the continental more may be done by operative interference than is needed or less than is required, the new formation of bone by the periosteum at the same time being necessarily interfered with.

The best practice, probably, is to be found between the two, and that is surgical interference about three to six months after the first appearance of symptoms—in acute disease and in small and narrow bones early, but in chronic disease and in large and thick bones late, interference.

The Operation of Sequestrotomy.—There is no operation in surgery more satisfactory than this, as it is usually unattended with danger and followed by complete success. In many cases it is simple, while in others it is complicated, the ingenuity of the surgeon being often taxed to devise means to carry out the object in view—viz., the removal of the sequestrum. Taking as a type of the affection the tibia in which the whole shaft or diaphysis is the seat of mischief, many cloacæ or fistulæ leading down to the dead bone through the periosteal bony case will probably be present, as is shown in Fig. 651; and with a probe introduced through an opening at one end and a second probe at the other end the surgeon may make his incision between the two down to the bone—that is, down to the new case of bone that envelops the old; and, having done this, he may peel back the periosteum with a raspatory or periosteal retractor, cut through the new bone that prevents the dead from being seized, by means of cutting pliers or chisel, and thus expose the necrosed shaft. The dead piece may then be seized by a pair of sequestrum forceps, and, where practicable, withdrawn. Should it be too long to extract through the wound, or should the opening in the bony case correspond to its centre, the sequestrum may be divided with a pair of cutting forceps and its two halves separately removed. At times a good elevator is of use to raise the sequestrum from its bed or to pry it from its attachment. Occasionally a good deal of the new casing of bone requires removal before the surgeon can get at the dead portion, and in the femur, where the whole shaft is necrosed, the upper part being larger than the lower, it may be necessary to chisel off or remove nearly the whole surface of the new shell of bone to admit of the removal of the sequestrum, it being impossible to withdraw through the lower orifice a piece of bone of larger diameter. In one case the simple enlargement of one of the cloacæ may be sufficient to enable the surgeon to seize and remove the bone, while in another it is necessary to lay two or more cloacæ into one. The operation should be done with as little interference with the soft parts and bony sheath as possible. The object having been obtained, the parts have only to be kept clean, raised, and left alone to fill up and heal.

FIG. 658.



Instruments Used in Sequestrotomy.

when a good recovery will generally follow. The instruments employed for sequestrotomy are illustrated in Fig. 658. In all cases Esmarch's elastic tourniquet should be employed to prevent hemorrhage.

When the whole shaft of a bone has been removed in early life, some shortening of the new bone or arrest of growth may be looked for, and in the case Fig. 659 such a result took place. The drawing was taken from a young woman æt. 25, from whom, at the age of 11, I removed the whole shaft of the tibia. The bowing of the limb was due to the bending of the fibula, which had grown naturally and bent to adapt itself to the shortened tibia.

Fig. 659.

Arrest of growth of Tibia after removal of Dead Shaft Fourteen Years before.

When the sequestrum cannot be raised from its bed, it had better be left alone, the opening made not being lost, as through it the sequestrum may subsequently be taken away or expelled naturally.

Dead bone the result of periosteal disease that is not covered in by new bone regularly exfoliates and rarely requires more than its simple removal by forceps, the soft parts covering it being divided; in this way large portions of the skull may be removed. I have taken away nearly half the frontal bone in a child, and also in an adult after syphilitic periostitis, I have removed large portions of all the cranial bones forming the vault. In one case large portions of the parietal, occipital, and frontal bones were removed.

When, after necrosis of a bone, the sequestrum presses upon an artery, fatal hemorrhage may ensue. Thus, Poland has recorded (*Guy's Hosp. Rep.*) three cases where such a result took place in necrosis of the femur, the popliteal artery in each having been wounded. Holmes has also recorded a case where a fatal hemorrhage from the lingual artery followed disease of the jaw, and another in which bleeding from the aorta occurred in caries of the spine. A preparation in the Guy's Museum (1243[30]) also shows a piece of necrosed tibia that perforated the anterior tibial artery and set up hemorrhage, necessitating the application of a ligature to the femoral artery.

When necrosis occurs in a joint, profuse suppuration and disorganization must ensue. Where this does not prove fatal and repair goes on, recovery may be prevented by the presence of diseased bone; and when this can be detected, its removal is the best practice. I have done this in the knee in three cases, and in the hip-, ankle-, shoulder-, and elbow-joints, with good result, having in each one removed large pieces of dead bone through sufficiently large incision (*Lancet*, Feb. 6, 1875).

Such cases as these must be looked upon as cases of necrosis, the joint having lost its special features by previous disease.

Necrosis of the carpal and tarsal bones is a common affection, for these bones die like the flat bones, no new sheath of bone preventing their exfoliation or removal. They may be treated freely, such incisions being made as will allow of their removal. The os calcis is the bone most commonly affected, and I have removed a large portion of it on many occasions with complete success. The epiphysis of the heel is not rarely affected. The scaphoid is sometimes involved, even at a very early period. The cuneiform and cuboid, separately or together, are also found diseased. Not long ago I removed from a boy's foot by two incisions the whole row of these bones, and an excellent foot was left—so good, indeed, that it was difficult to believe that so much bone had been taken away (Fig. 618). The same may be said of the carpal bones. Indeed, in these cases true conservative surgery is of great value. The removal of dead bone, however extensive, is a very safe operation, and followed by results which are often startling by their success. There is no limit to the removal of necrosed bone, wherever found, or to the amount of natural repair. To amputate a limb, foot, or hand for necrosed bone until the surgeon has proved that the removal of the diseased part is impossible or the simple removal proved unsuccessful is scarcely a justifiable proceeding.

To gouge away bone that is inflamed and not dead or to excise inflamed bones that may undergo repair is a proceeding which is practically bad and scientifically unreasonable; for all bone that is not dead is reparable, and to interfere with it mechanically is bad surgery.

The great success of the operation for necrosis (sequestrotomy) is unquestionably due to the introduction of anæsthetics. Prior to their introduction the operation was difficult and dangerous; indeed, it was rarely performed, amputation having been too often substituted.

CARIES.

No word in surgery has been used with greater carelessness and with a greater variety of meanings than "caries," nor is there one that now conveys a less definite idea. In this section it will be applied to an unhealthy inflammation of bone, chiefly of cancellous bone. When superficial, it appears as ulceration or molecular death of bone; when deeply placed or central, it is often associated with necrosis or suppuration and may or may not be due to syphilis or struma. It is *pathologically* remediable and reparable, and whenever found is mixed up with reparative processes. In patients of feeble power and some constitutional cachexia, or where the disease is very extensive, it may, however, *clinically* be incurable, and thus require surgical interference. Nevertheless, in its nature it is inflammatory, and should be looked upon as a curable affection depending more upon constitutional than upon local causes. In this respect it differs from necrosis.

A bone is said to be *carious on its surface* when, being exposed, it presents an irregular and worm-eaten appearance, is suppurating, and the sore throws off a serous, more or less offensive purulent discharge which contains excess of phosphate of lime mixed with small fragments of bone tissue. This affection is generally associated with an ulcer or open sore of the skin over the parts and more or less thickening of the periosteum and bone around and beneath the diseased portion. It is always vascular and readily bleeds on being touched. It is occasionally painful. At times the bone is soft and yields to the pressure of the probe; in other cases it is hard. When it attacks the articular surface of a bone, it often forms pits with sharp, well-defined edges; and under these circumstances has been looked upon as scrofulous, but with what amount of truth it is difficult to say. When it is associated with syphilis, it follows the suppuration of a node. At times it is complicated with the tubercular thickening of the surface of the bone itself or with what Paget has described as annular ulcers, in which a spot of ulceration is seen which goes on to form a circular trench round a worm-eaten surface. This trench increases in width and depth and at last loosens a sequestrum, which separates and leaves a circular depression. In bones of the skull this ulcer may involve one or both tables. *This ulcer* may subsequently heal, leaving a permanent depression. *Caries*, in fact, is inflammation and ulceration of bone; *necrosis* in its death *en masse*.

A bone carious in its interior is vascular, although softened sometimes almost to rottenness, and easily breaks down; it discharges often a thin, sanguineous, fetid, semi-purulent fluid which contains fragments and elements of bone: abscesses which generally communicate externally through the soft parts often coexist in and about the bone and are occasionally combined with necrosis. In the spine, where it is the more commonly met with, it is often unassociated with any external suppuration or discharge, though the bone, with the intervertebral substance, softens down and undergoes extensive molecular death, much loss of bone taking place, the particles being apparently reabsorbed and carried away, and complete recovery following without any external discharge. Around the inflamed or carious bone the cancellous tissue is generally infiltrated with more or less organizable inflammatory lymph, the nature of which depends much upon the character of the inflammation. In feeble and strumous subjects the fluid will be of a serous, oily, and non-plastic kind (Black *On Tuberculous Bone*, Edinburgh, 1859), the cancellous bone becoming more cellular and lighter. In more healthy types the effusion will be plastic and organizable, the bone becoming more compact. In one case no consolidation of the surrounding bone will be present, while in another condensation of the bone to a greater or less extent will be found.

Under all circumstances the nature of the inflammatory action turns much upon the constitutional power of the patient, the disease tending in strumous and feeble subjects to widen, but not to repair, while in more healthy subjects it inclines to a local action and recovery.

In rare examples genuine tubercle may coexist with the inflammation.

Treatment.—Looking upon caries as an inflammatory affection, and consequently as curable, it is to be treated on somewhat similar principles as inflammation of other parts. When the general powers of the patient are feeble, they ought to be stimulated by tonic medicine and regimen; local pain is to be soothed and torpid action stimulated, but all mechanical and surgical interference should be avoided, except for the removal of dead bone. In superficial caries or ulceration, when rest, elevation, soothing, or possibly stimulating, applications, with tonics, fail to induce a healthy reparative action, local stimulants are sometimes of use, and the local application of such acids as the acetic, nitric, or sulphuric, strong or diluted, has often a beneficial action. Mr. Le Gros-Clark strongly recom-

mends acetic acid as the best solvent of the inorganic constituents. He uses as a dressing one part of Beaufoy's No. 11 acid to five parts of water. George Pollock speaks highly of the value of sulphuric acid, at first diluted with equal parts of water, and subsequently pure, the acid destroying the diseased bone to which it is applied and setting up a more healthy action in the parts beneath, thus hastening recovery. Boinet advocates the use of iodine, at first diluted, and then strong; others recommend phosphoric acid. Dr. Fitzpatrick applies the Vienna paste or potassa cum calce to the surface of the inflamed bone, as well as to its deeper parts after puncturing them. The actual or galvanic cautery has also been employed, and in superficial caries it seems to be valuable. In deep-seated or endosteal caries some speak highly of operative interference, either by the gouging out of the diseased tissue or by the excision of the inflamed or carious bone; but I allude to this treatment only to condemn it, since I believe it to be both unnecessary and injurious. It is unnecessary, as in the majority of cases recovery can be secured without it; it is injurious, since gouging, as a rule, adds to the irritation, and thus tends to the spread of the disease, and often excites more general inflammation in the bone or endosteum.

Excision of the diseased bone is not an operation that can be highly recommended, yet it may be done, doubtless, with success, as in the tarsus; and many an inflamed or carious os calcis has been successfully excised. There is however, a strong doubt as to the necessity of the operation. When the bone dies, the necrosed bone may, and should, be removed; but in all other conditions it is reparable under constitutional treatment and local applications. Surgeons who interfere surgically with carious bones usually prefer excision to any partial operation. Superficial or periosteal caries may be regarded and treated as an indolent ulcer in other parts, the repair being more chronic in bones than in soft tissues; deep-seated caries or inflammation may be also considered much in the same light. When syphilis complicates the case, iodine in full doses, in one of its forms, combined with any tonic that may appear to be needed, and as a local application, is of great use.

TUMORS OF BONE.

Tumors of bone vary but little in their pathology from tumors of other parts, and whatever differences exist arise from the peculiarity of the tissue in or around which they grow. Tumors of bone, as of soft parts, partake of the nature of the tissue in which they are developed; thus, a tumor that in a fibrous organ would be more or less fibrous when originating in or upon a bone is mixed with bone, and a carcinomatous tumor of soft parts becomes a malignant osteoid cancer of a bone. In addition to these, there are special tumors known as the myeloid and the cartilaginous.

Excluding, therefore, enlargements of bone due to inflammation, there are bony outgrowths or *exostoses*, *cartilaginous* and *myeloid* tumors, all being, as a rule, of an innocent nature; there are the *osteo-sarcomatous* tumors, or fibrous tumors of bone, including those that have a periosteal as well as an osteal origin, the fibrous and osseous elements

FIG. 660.

FIG. 661.

Tumor as Discharged from Cavity in Fig. 660. (Weight nearly 15 oz.; circumference 11 by 9 inches. Mr. Hilton's case. Prep. Guy's Mus. 1666[8].)

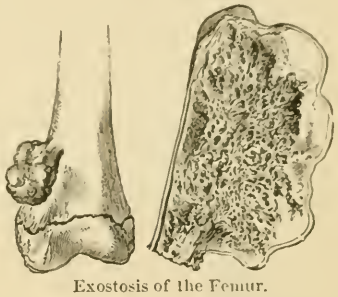
predominating in various degrees; and, lastly, there are the *malignant tumors of bone*, whether of the soft or the hard kind, osseous matter being mixed up largely with both, the disease acquiring the name "osteoid cancer" when the bony elements predominate. These tumors grow from the periosteum as well as from the bone.

Exostoses may grow from almost every bone; from the cranium inside and out, as well as from the bones of the trunk and extremities. Those of the cranium are usually

very dense and of ivory-like hardness; indeed, they are often called "ivory exostoses," and sometimes are so hard that they cannot be removed. They may have broad bases, but at times are pedunculated, and in singular examples they occur as loose growths; these latter have generally occurred in the frontal sinus and should be described as *enostoses*. Mr. Hilton has recorded an interesting case (*Guy's Rep.*, vol i.) in which such a bony tumor, of twenty-three years' standing (Fig. 661), fell out of a large cavity in the superior maxillary bone (Fig. 660). The man in 1865, thirty years after the operation, was well, although disfigured by the hole in which the tumor had rested; and in a former page (595) I have recorded a case of the same affection and figured it (Figs. 341, 342). These bony growths are more common about the orbit and air cells of the head than elsewhere. True ivory exostoses of these parts do, however, occur, and at times attain a large size. Birkett has related (*Guy's Rep.*, 1868) such a case of Dr. V. Bruns, in which an ivory tumor of seventy-four years' existence, weighing ten pounds, grew from the occipital bone of a man æt. 80. Exostoses from the jaws—or, rather, alveoli—are often called "epulis."

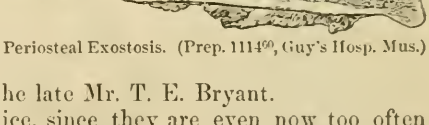
Exostoses on the extremities are not uncommon, and are apt to spring from the point of junction of the shaft with the epiphysis (Virchow considering this as the usual seat) and at the attachment of muscles. They are mostly outgrowths of bone capped with cartilage, by which they grow (Fig. 662); exostoses, however, of long standing have an osseous shell. They have at times broad bases, but more frequently narrow peduncles. They are often curved or crested, assuming odd shapes, and may grow to a large size. In exceptional instances they may die or necrose without any known cause, and as a result of accident they may be broken from their attachment. I have seen this in an outgrowth from the femur of a girl æt. 12 who received a kick from a donkey, and a second case, in a patient of Mr. Birkett, with an exostosis of the tibia. When broken off from their bony attachments, they may in exceptional instances wither, but, as a rule, they will again adhere. In a patient of Mr. Maunder, in whom an exostosis of the femur was subcutaneously separated from the bone, adhesion took place, although at a better angle. At times exostoses are multiple. In a girl æt. 16 I found exostoses of different sizes on both tibiæ and both hands, one humerus, one radius, and ilium, and in two patients, nine and sixteen years of age respectively, five bones were so affected.

FIG. 662.



Exostosis of the Femur.

FIG. 663.



Periosteal Exostosis. (Prep. 1114[60], Guy's Hosp. Mus.)

Some exostoses have a *periosteal* origin, the result of organized inflammatory products, when they are usually diffused. Fig. 663 shows this well and was taken from a patient of my father, the late Mr. T. E. Bryant.

Ungual exostoses deserve a special notice, since they are even now too often mistaken for what is called "ingrowing toe-nail." They are generally found on the distal phalanx of the great toe (Fig. 64, page 177), but Prep. 1287, Guy's Museum, shows a specimen from the little toe, and I have had under care two cases in which an exostosis grew from the ungual phalanx of the thumb, and one in which it was attached to the index finger. Liston in 1825 first drew attention to the nature of these cases.

The osteophytes and the outgrowths of osteo-arthritis are not classed amongst the exostoses.

TREATMENT.—When surgical interference is called for, nothing but the removal of these growths can be entertained, their bases being well levelled down to the bone, or even scooped out. When, however, they are placed near joints, this practice should be well considered. In a case in which an exostosis projected from the inner condyle of the knee I divided its base subcutaneously with a chisel and pressed it back into the popliteal space, where it remained without giving trouble. In cranial exostosis this operation may be not only difficult, but impossible; still, the attempt, wherever it can, should be made, for many successful attempts have ended in procuring the death of the exostosis and its subsequent exfoliation. In such a case, treated by Mr. Cock, where the removal of the whole from the orbit was impossible from its hardness, a part was removed, and what remained subsequently died and sloughed out.

Intracranial exostoses are rarely made out during life, and are at times associated with epilepsy.

The following analysis of 120 cases of exostoses will show the seat of these growths. 45 were tabulated by my colleague, Mr. Birkett, in *Guy's Reports*, and the remainder are from my private notes. Cases of epulis are excluded.

Frontal bone	3	Clavicle	3	Fibula	4
Upper jaw	1	Humerus	15	Patella	1
Lower jaw	3	Ulna	1	Tarsal bone	1
Bodies of cervical vertebræ	1	Radius	2	Metatarsal	1
Sacrum	1	Fingers	5	Ungual phalanx of great toe	25
Ribs	3	Ungual phalanx of thumb	2		
Ilium	1	Femur	18	Sole of foot	1
Scapula	10	Tibia	18		

Three of the cases tabulated were examples of multiple exostosis; when the radius was affected, it was in common with other bones.

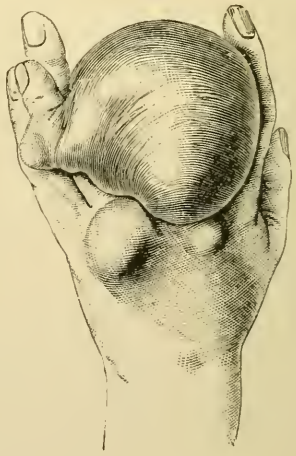
Enchondromatous or cartilaginous tumors of bone are most commonly met with in the phalanges and metacarpal bones. They are, however, seen surrounding bones having a periosteal origin or growing from the bones of the upper jaw. A remarkable instance of this has been recorded in Chapter XIII. and figured in Fig. 241. It would appear that such cartilaginous tumors are more prone to attack the scapula than any other bones, and I have seen several such cases. Mr. Birkett has recorded and figured a fine specimen in the *Guy's Reports* (1866).

The bones of the pelvis are at times the seat of such growths. I have the records of a remarkable instance in which the pelvic surface of the ilium was the seat of the affection, and of another in which a middle-aged woman had an enormous cartilaginous outgrowth the size of a cocoanut springing from the pelvis and occupying the inner side of the right thigh, beneath the adductor muscles. The case from which Fig. 664 was taken

FIG. 664.

Enchondroma of Pelvis.

FIG. 665.



Enchondromatous Tumors. (From a model in the Guy's Museum.)

occurred in the practice of my friend Mr. Knaggs of Huddersfield. It was of twenty years' growth. Cartilaginous tumors of bone usually originate in it, and are found in young subjects when the bone is growing. They are generally covered by a shell of the bone in which they originate; the shell is at times expanded in all directions, but more usually in one. In Fig. 665, taken from a model in Guy's Museum, this mode of growth is seen. In Fig. 22 the section of such a growth is well illustrated.

These cases are occasionally multiple, congenital, and hereditary. Thus, in 1881 a man æt. 53 came under my care for a fracture of his thigh. He had at least a dozen outgrowths of bone or cartilage (ossifying enchondromata) upon his body, connected with

the shafts of his long bones. He was born with them. His father had three or four growths of the same kind as congenital tumors, and his son was literally covered with them from birth, some being as large as oranges. My friend Dr. Shuttleworth of Lancaster has published a like case in the *Brit. Med. Journ.* (December 17, 1881).

Cartilaginous tumors are usually of slow growth and painless, with a smooth outline. At times they undergo decay and soften down, discharging a brown-colored serous fluid unlike any other tumor, and under such circumstances are prone to disseminate like cancer. At other times they ossify and turn into bony tumors, the "bulbous exostosis" being often an ossified enchondroma.

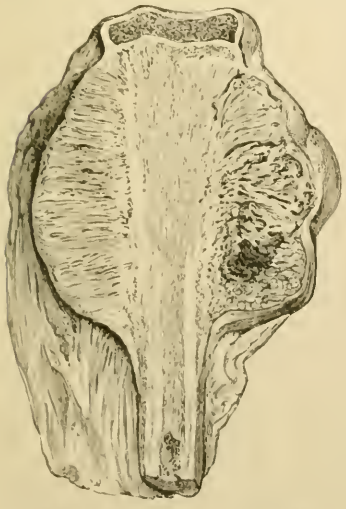
TREATMENT.—Where it can be done a cartilaginous tumor should be scooped out of a bone, and in the phalanges and metacarpal bones this practice is usually successful. Extreme examples of the disease demand amputation or excision of the affected bone.

Enchondromatous tumors are at times recurrent, and in rare examples return as malignant tumors in other parts of the body. Such growths, having a periosteal origin, are usually rapid in their increase and diffused. True cartilaginous tumors of bone are usually circumscribed, and often multiple. The bones of the hand are at times much involved.

Osteo-sarcoma is a term of broad signification, and is usually applied to the fibrous tumor of bone in which fibre tissue and bone elements predominate in various degrees. Wilks believes "that they are altogether comparable to the fibrous tumors of soft parts." They usually have a periosteal origin—*periosteal sarcoma*—and even in exaggerated examples the shaft of the affected bone may be clearly traced through the growth. The tumor is usually circumscribed, with a fibrous capsule and divided by fibrous or ossific rays into different portions; at times the fibrous element predominates, at others the osseous. The disease is usually seen attacking the ends of the shafts of bone, and not the epiphyses. All these points are well seen in Fig. 666.

Cartilage is often found to be mixed up with the fibrous and osseous elements and in proportion to the amount of bone matter entering into the formation of the tumor it may

FIG. 666.

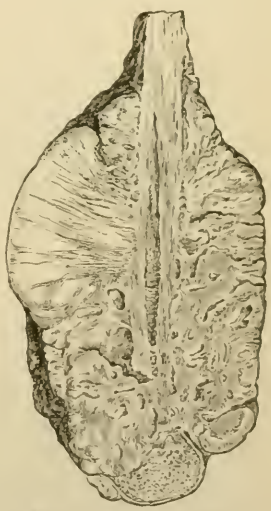


Periosteal Osteo-Sarcoma. (Drawing 20, Guy's Hosp. Mus. Key's case.)

FIG. 668.

Appearance of Limb affected with Osteo-Chondroma.

FIG. 667.



Osteo-Chondroma of Femur. (Drawing $\frac{875}{2}$.)

be regarded as innocent or otherwise; bony periosteal growths are rarely cancerous. When fibrous tissue, and more particularly the softer forms, predominate, the tumor is prone to recur at the same spot or in some other organ, as is the case with cancer.

Osteo-chondroma is applied to a tumor involving bone and made up of cartilage and bony elements in variable degrees, the cartilage taking the place of the fibrous tissue of the osteo-sarcomatous tumor. In one case bone will predominate; in another, cartilage. The disease is usually of slow growth and simple in its nature. In the case of a woman æt. 34, from which Fig. 667 was taken, the disease had existed for three years. Fig. 668 represents the same tumor, taken during life.

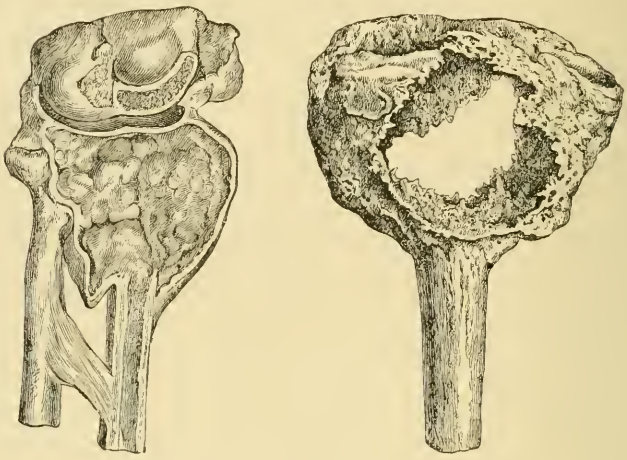
Myeloid tumors of bone are probably innocent, exceptional instances being

on record in which a return in the part or in internal organs took place. They usually attack also either the epiphyses or the epiphysial ends of the shafts of bones (Fig. 669).

Fig. 669.

Expansion of Condyles of Femur from Myeloid Tumor.

Fig. 670.



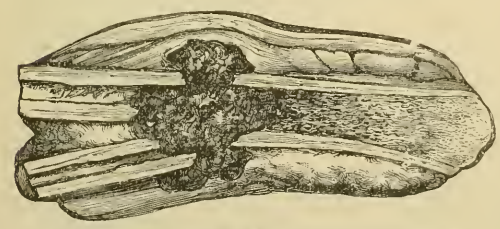
Myeloid Tumors Expanding Bone. (Guy's Hosp. Mus.)

I have seen the disease, however, involving the shaft of the radius and upper jaw, and Paget has described it as attacking the breast. It begins commonly in the centre of the bone, which it expands, forming a globular shell of bone—the spina ventosa of the older writers (Fig. 670). The interior of this shell is made up of fibre tissue, or it may be cystic, the cavity being divided by means of fibrous septa into more or less well-marked cystic divisions. The spaces themselves, or loculi, contain the characteristic myeloid material—"an opaque white, intermixed with a semi-transparent gelatinous-looking substance of a *cherry-red color*"—and their substance is made up of the characteristic polynucleated and irregular myeloid cells.

When the tumor encroaches on the joint, the cartilage is usually spread out over the tumor, but intact. These tumors were originally mixed up with the cancerous or fibroplastic of Lebert. They are found, likewise, in the gums as "epulis," and in other parts. In a specimen of myeloid tumor of the upper jaw which I removed from a girl æt. 8 the structure was very dense (*Guy's Rep.*, 1873, 1874, 1877).

Cancers of bone, as of other parts, show their malignancy in effecting the utter destruction of the bones in which they are developed. They may originate in the periosteum or in the bone, but in either case both tissues will be eventually affected. When they originate from the periosteum, the bone may be found in parts running through the mass and with cancerous elements surrounding the shaft (Fig. 672); but when the disease has existed for any period, the same cancerous elements will be found in the shaft itself and destroying it. When the disease begins in the bone, it is usually in the medulla by one or more different centres, which by their increase expand the bone and utterly destroy it (Fig. 671). The bones under these circumstances are very brittle and apt to break on the slightest force, even by ordinary muscular action, the fracture probably being the first indication of the presence of the cancerous disease. I have known fracture to occur under these circumstances by a patient turning in bed, crossing a street, or walking down stairs. In the majority of cases of cancer of bone, bone elements have little to do with the disease, though in what is called the true osteoid cancer masses of bone of a condensed kind appear in the medulla, and gradually grow until a large osseous mass of disease is formed.

Fig. 671.



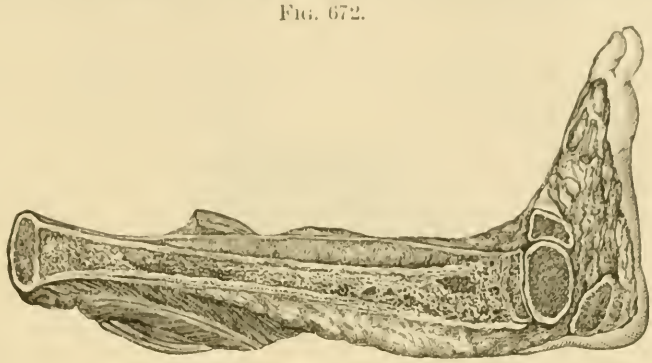
Fracture of the Femur from Muscular Action at the Seat of a Local Cancer in a Man æt. 28.

In Fig. 673 this form of disease is well seen, and was taken from a patient of Mr.

Aston Key æt. 26 in whom masses of bone and cartilaginous tubercles were found in the lungs, pleura, and lymphatic glands after death.

The *periosteal* form of cancer (Fig. 672) grows more rapidly than the endosteal or interstitial, very quickly assumes a large size, and is not often accompanied by pain; the

Fig. 672.



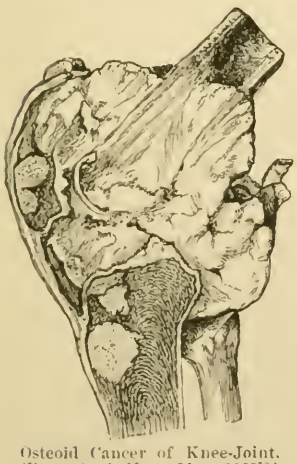
Periosteal Cancer of the Tibia.

swelling is rarely globular in its outline, but loses itself both above and below in the surrounding parts; and in the integument covering it large full veins, from obstruction to the deep veins, will likewise be seen. It will possess a semi-elastic feel and often yield to the touch an unequal sensation as to density. *Endosteal* cancer is commonly attended with a dull aching pain due to the expansion of the bone. Its increase is at first slow; but when it has so destroyed the bone as to have reached the periosteum, pain will be lessened, while the increase of the tumor will be more rapid. This form of cancer is more frequently secondary than primary.

Primary cancer of bone or periosteum is more common in children than in adults.

Epithelial cancer may attack a bone by the extension of the disease from the soft parts, as seen when cancer of the lips spreads to the jaws, and skin cancer may also

Fig. 673.



Osteoid Cancer of Knee-Joint. (Prep. Guy's Hosp. Mus., 1165[30].)

Fig. 674.

Cancer Attacking Necrosed Tibia.

extend downward into a bone of an extremity and cause great destruction. At times a bone that has been the subject of necrosis may become the seat of cancer, and within a short time I had three such cases under care, in two of which the tibia was the seat of the disease, necrosis having existed in both for upward of twenty years, and in the third, although the femur apparently became necrosed twenty-two years before the man came under my observation, the cancer evidently began in the skin over it and extended down the sinuses into the bone. Fig. 675 was taken from the limb of this patient during life; Fig. 674 was taken from the limb after amputation at the knee-joint in another case. In a man I treated years ago the os calcis and the soft parts over it were the seat of the disease, and the bone after amputation was found infiltrated with cancerous epithelial elements; and more recently (1878) I amputated the foot of a woman which had been the seat of cancer for twenty-five years, and of necrosis for ten. For other cases see *Lancet*, February 23, 1884.

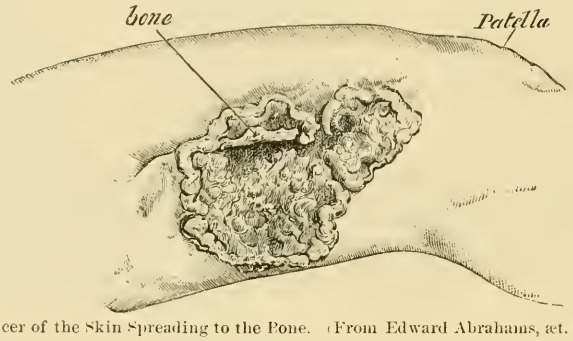
Diagnosis of Tumors of Bone.—In most cases only an approximation to truth can be made.

A *globular* tumor situated in the articular end of a bone, and expanding it, but not involving the joint, of slow, steady, and often painless growth in a young subject or adult, is probably myeloid.

A more *elongated or ovoid* tumor situated in the shaft of a bone of more rapid growth, with full veins in the soft parts covering it, and a semi-elastic, unequal feel, in a young subject, is probably a periosteal cancer.

A *firm, fibrous growth* of a somewhat globular form, of gradual increase and unequal surface, fibrous in one spot, bony in another, in an adult, is probably an osteo-sarcoma,

FIG. 675.



Cancer of the Skin Spreading to the Bone. (From Edward Abrahams, æt. 42.)

while a more indurated growth with a botryoidal outline and a similar clinical history is probably an osteo-chondroma.

Pain, rapid and diffused growth, with unequal density, glandular enlargement, venous obstruction, and wasting, generally indicate cancer.

Gradual, painless increase, a defined contour, globular, botryoidal, or in ridges, with no venous obstruction, glandular enlargement, or disturbance of the general health, usually indicate a benign tumor. The more globular the outline, the greater the probability of the growth being myeloid; the older the patient and the more botryoidal the growth, the greater the chance of its being enchondromatous; the slower the growth, the more local and divided into septa, the greater the chance of its being osteo-sarcoma.

When a tumor is periosteal, by making firm pressure below the tumor the bone will be made out to be on a lower level than the growth; when the tumor is endosteal and the bone expanded, on making firm pressure below the surface of the bone the bone will be felt to rise gradually from the unaffected part over the surface of the growth, so as to form a shell for it.

TREATMENT.—A tumor of bone can be effectually treated only by excision; and when it involves the articular end of the bone and encroaches upon a joint, amputation is too often necessary. When the whole bone is involved, as in a cancer, nothing but amputation can be entertained; and it is usually well to amputate high above the disease. If the tumor is placed in the head of the tibia, an amputation at the knee-joint may be performed, or, where this is inexpedient, just above the condyles. If the condyles of the femur are the seat of the disease, the amputation should be at the centre of the shaft, it being justifiable to amputate at the hip-joint only when the disease is too extensive to allow of an amputation through the bone, for the hip-joint operation is most fatal and should be performed only when any less severe measure is impossible. In an evident cancer of the lower half of the femur, where amputation is to be performed, it had better be at the hip-joint, though in doubtful cases the limb may be removed just above the growth.

In the upper extremity, however, where amputation at any of the joints is, as a rule, successful, it is wise in cancerous disease to remove the whole of the affected bone and amputate at the articulation above. In periosteal cancers the whole bone should always be removed. Amputation for myeloid and simple tumors is generally successful, and a young woman for whom I amputated the thigh for myeloid disease in 1861 was still well seventeen years after the operation.

If a tumor involve the shaft of a bone or the extremity of its diaphysis, but not the epiphysis, and the growth appears to be local, and probably simple, an attempt should first be made to deal with it locally, to scoop or to turn it out, the more severe measure of excision or amputation being alone had recourse to should the minor fail. In the case of the enchondromatous and fibrous tumors of bone, the minor measure is usually successful. In fact, in the treatment of tumors of bone, when the disease can be removed without making any great sacrifice of other parts, the attempt should be made. Amputation as a primary measure should be reserved for clearly cancerous cases or diffused growths, or for such as involve the articular ends of the bones, and, consequently, the

joint. Some interesting cases illustrating the advantage of excising portions of the long bones when the seat of myeloid and other tumors have been recorded by Messrs. Lucas and Morris in the tenth volume of the *Clinical Society's Transactions*.

Pulsatile tumors of bone are cancerous, as a rule, though they may be aneurismal. Cancerous tumors of the skull are frequently pulsatile, and in one well-marked case I had under care some time ago, in which the frontal bone was the seat of the disease, this pulsatile condition was its early symptom, the swelling being comparatively unnoticed. All pulsatile bone tumors have an interstitial origin and expand the bone, the new growth receiving its impulse from the large arteries that supply it. Gray (*Med.-Chir. Trans.*, vol. xxxix.) has recorded an example of pulsating myeloid. True cases of *osteo-aneurism* are rare. Mr. Bickersteth of Liverpool has recorded such a case, and I had the pleasure of examining it carefully with Mr. W. Adams and reporting upon it to the Pathological Society (vol. xix.). It was undoubtedly a genuine case of this disease involving the tibia. Mr. Mapother (*Dublin Med. Trans.*, 1863) has recorded another. These cases are made up of expanded bone from aneurismal dilatation of the vessels of the bone.

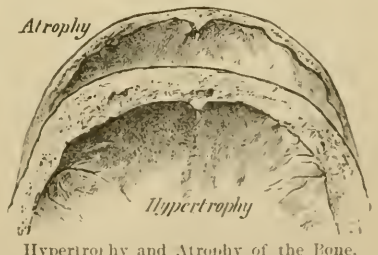
TREATMENT.—Pulsatile cancerous tumors of bone, like the non-pulsatile, ought to be treated by amputation; true osteo-aneurisms of a limited size, when they can be made out, should be dealt with by local extirpation or by destroying them by means of the actual or galvanic cautery, and when very extensive by amputation. Dr. Mapother cured his by the actual cautery, and Mr. Bickersteth by amputation.

Cysts in bone are occasionally met with, and may be serous, sanguineous, or hydatid. The former two are most commonly met with in the jaws, and in Chapter XIII. attention has been directed to them. Whether they ever occur in the long bones is an open question, though in 1870 I trephined the enormously enlarged and expanded shaft of the tibia of a man æt. 30 for gradually progressive disease of fifteen years' standing, the bone having been the seat of a fixed pain in its centre. I did so under the impression that the case was one of abscess, but, having perforated a dense shell of bone an inch thick, I came upon a cavity the size of an egg which contained *no* pus, though it was lined with the soft velvety material usually met with in abscess, and what escaped from it was not to be distinguished from the blood that flowed during the operation. The operation was quite successful, and a rapid cure ensued. I believe this case to have been one of cyst in the bone.

Hydatids are found in bone, and in Guy's Museum there is the head of a tibia containing a cyst or echinococcus which holds many smaller cysts within it; also another specimen illustrating the existence of hydatids in the vertebræ. In 1869 I treated with Dr. Freund a case in which a large hydatid escaped from the expanded condyle of the humerus after a puncture in front of the joint. The hydatid had clearly made its way from the bone into the elbow-joint and through this externally; a good recovery with a stiff joint ensued.

Hypertrophy and atrophy of bone are pathological realities, although during life it may be a difficult, if not an impossible, task to recognize such conditions. Hypertrophies and chronic inflammatory changes are consequently often mistaken the one for the other, although in the former the enlargement is gradual and painless and in the latter associated with local pain and other evidence of inflammation. In some cases the bone is enlarged and its cancellous structure expanded (porous hyperostosis); in another it is enlarged, but at the same time more dense (sclerotic hyperostosis). These changes are best seen in the calvaria (Fig. 676). In Prep. 1068[35] in Guy's Museum the bone is at least double its normal thickness. In rare cases the hypertrophy is clearly due to increase of function, as shown in another preparation in Guy's Museum (1000[15]), taken from a man who was a paralytic and who had used his arms for progression: here the bones of the upper extremity are larger than those of the lower. In the majority of cases, however, the sclerosis of bone is due to inflammation, and in the case which Sir P. Hewett mentioned in his well-known *College Lectures*, where the man's skull increased so imperceptibly year by year as to be recognized only by the gradual increase in the size of his hat, the disease was traced to an injury.

FIG. 676.



Hypertrophy and Atrophy of the Bone. (From prep. in Guy's Museum.)

This affection is pathologically interesting, though surgically nothing can be done for it.

Atrophy is most commonly met with in the shafts of bones that have not been used for many years, as in paralytic subjects and persons who have been the subjects of joint disease, in the bones of the aged, and in those that have been injured. The bone may become a mere shell, its cancellous tissue being expanded and its cells filled with a fatty matter.

When atrophy follows injury, Curling's suggestion (*Med.-Chir. Trans.*, vol. xx.) that the causes may be found in injury to the medullary artery is probably right. This probably happened in the case of a man who came to me with an ununited fracture of the humerus, in whom I found the bone, on exposing its ends for operation, to be a mere shell and not half its normal thickness. It, however, cannot be the only explanation, as Norris has recorded (*American Journ. of Med. Sci.*, 1842) a remarkable case in which, after a double fracture of the humerus about its centre, the whole bone disappeared, the fore-arm subsequently swinging as a thong, while the arm became shortened six inches; the bone disappeared "by the gradual action of the absorbents."

In these cases spontaneous fracture or fracture from slight muscular action is very prone to occur.

These cases of hypertrophy or atrophy must not be confused with the elongation of the shaft of a bone which is due to inflammation, or to the shortening of a bone from arrest of its growth following disease or the removal of the shaft, or to some injury to the epiphysial cartilage that connects the shaft with the epiphysis; for it cannot be too strongly impressed upon the student's mind that any disease or injury which interferes in any way with the nutrition of the epiphysial cartilage through which the long bones mainly grow will be followed by arrest of the bone's growth, and consequently by the shortening of the limb—that is, when the disease or accident occurs in early life during the period of growth. I have before me the notes of several cases where this result ensued. In one in adult life the tibia was an inch shorter than its fellow after the removal of a necrosed shaft in childhood (*vide* Fig. 659), in another nearly the same amount of shortening followed an injury to the superior epiphysial line of the tibia, and in a third the same result followed a displacement of the lower epiphysis. In all these cases the fibula was curved outward, the shaft of the bone bent, and the outer malleolus much lower than the inner, the bone having grown as the others. In one case the head of the fibula was partially displaced outward.

Mollities ossium, or osteo-malacia, is a rare affection, and its cause is wrapped in obscurity. It is found in men in about one case in ten of the affection, and in women is usually discovered during, even if it does not originate in, pregnancy. It chiefly attacks subjects who from some cause or other have been subjected to prolonged depressing influences, more particularly upon the nervous system.

My colleague, Mr. Durham, in an able paper on the subject (*Guy's Rep.*, 1864), writes "that mollities ossium is to be regarded as a particular expression, as it were, of a general morbid condition of the system, rather than as a special disease of the bones themselves;" and I believe there can be little doubt as to the soundness of the opinion. It should never be confounded with rickets or with the fragility of the bones met with in the aged or demented.

Symptoms.—"The first symptom of the disease," writes Durham, "is pain, more or less peculiar in character, always deep-seated, and greatly increased by pressure or motion, sometimes coming on suddenly and with extreme severity, sometimes commencing vaguely and insidiously, and gradually becoming almost insupportable; sometimes wandering, at other times fixed for a period to some particular spot, and subsequently spreading to other parts; sometimes intermitting, at other times unceasing. In the majority of cases the pain appears to have been first felt in the lower half of the spine, the pelvis, and loins, but in some it commenced in the feet, knees, or other parts of the lower extremities; the pains are often looked upon as rheumatic. Associated with the pain there has always been noticed on the part of the patient, at a very early period of the malady, a feeling of general lassitude and disinclination to do anything. This feeling has increased more or less uniformly, until it has ended in actual inability to make any exertion whatever; and with the early local changes are associated an uncertain, feeble gait and continual fear of falling."

Symptoms that are more or less directly associated with the softening and absorption of the bones are the next to appear, such as diminution of stature, deformity of the spine or pelvis, some curvature or fracture of one or other of the long bones; and as time progresses these indications multiply, *flexibility* conjoined with fragility being the distinguishing character of the bones in this disease.

The urine almost always contains a considerable excess of lime salts. The disease is rarely attended with any general or local symptoms of inflammation. The changes observed in the bones are carefully described by Durham. Increased vascularity appears to be an early symptom, the large grooves seen in the cranial bones being very striking; next, the bony matter is seen to be more opaque and less uniform than natural; sometimes it is irregularly granular, "as if some disunion must have taken place between the component elements of the bony matter."

The lamination of the bones next becomes less distinct; the laminæ of the Haversian system appear more or less fused together; the bone corpuscles become wider, although not with certainty more numerous. At a later date the earthy matter becomes absorbed; the Haversian canals become surrounded by a transparent ring of animal matter, which ring then becomes disintegrated and absorbed. By this process the Haversian system becomes destroyed, the bone assuming a hollowed-out, porous, or somewhat sponge-like appearance. The contrast between the healthy and diseased bone is well seen in Figs. 677, 678.

Fig. 677.

Section of Normal Occipital Bone.

Fig. 678.

Section Affected with Mollities.

(Durham, *Guy's Rep.*, 1864.)

The same changes occur in the cancellated as in the compact tissue. In the more advanced stage the bone disintegrates rapidly; *débris* of tissue, such as the remains of blood vessels, shreds of membrane, fat and oil globules, with "marrow cells," fill up the large spaces.

Chemically, the inorganic constituents are greatly diminished and chemical disunion and physical disunion coexist, the earthy matter being more readily dissolved out of the diseased than out of normal bone. "In healthy bone," writes Durham, "the constituents are combined; in diseased bone they seem rather to be mixed. The animal constituents are likewise more fatty and less nitrogenized than in normal bone; the fat is more free. In the mineral constituents the proportion of the carbonate of lime to the phosphate is much diminished."

Prognosis and Treatment.—The prognosis in these cases is always bad, although the possibility of a cure should not be doubted. Trousseau relates cases in which a good result was obtained under the combined influence of rest, warmth, good food, and cod-liver oil, the deformity, of course, remaining. Lime salts ought not to be given in these cases, as they cannot be retained; and to give them, adds Durham, is only to throw additional work upon the excreting organs.

Rickets is an affection of early childhood, or rather of young life, since it has been known to affect animals, as proved by a skeleton of a West African baboon shown at the Pathological Society of London in 1883 which exhibited the characteristic changes in the epiphyses of the long bones, and by the head of a monkey which was a fine example of craniotabes. In neither of these cases could syphilis be said to have had any influence. It is more of an acquired than an hereditary affection, but it may attack a fœtus *in utero*. It is said by Sir W. Jenner to be the commonest of the diathetic affections among the London poor. It is, however, found in the families of the higher classes, and it is essentially due to some malnutrition of the body, connected, probably, with bad feeding and the use of farinaceous in lieu of animal food, the bones during their period of growth expanding at their epiphysial ends and bending in their shafts, and being very prone to incomplete or green-stick fracture.

Symptoms.—"Displacement and obliquity of the epiphyses may ensue, from softness and flexibility of the layer of bone uniting it to the diaphysis, as is seen more especially

in the ribs, but a slighter degree of epiphysial obliquity is noticed in many of the joints of the long bones, such as the knee or ankle; the weight of the body is thus thrown unequally, so that one set of ligaments has to bear more traction than another. These ligaments then yield and the joints become loose, so that rachitic knock-knee (*genu valgum*) or bow-legs (*genu varum*) is formed.

"From sustaining the weight of the body the femur bends forward, the tibia usually forward and either inward or outward, the greatest amount of yielding being where the bone is thinnest and weakest. In many cases we find the os femoris bent forward, with anterior and outward curvature of the tibia, knock-knee and flat-foot being coexistent in the same individual. Just so far as the rachitic condition extends, so may we look for abnormities of form; thus, the *pelvis* may acquire some of those well-known contractions of its outlet which are matters of such grievous moment to women at the period of parturition," the pelvis either retaining in adult life the small size and imperfect development of infancy or becoming narrowed as to its cavity in one or other of its diameters.

The chest also undergoes allied changes, and Mr. Shaw has well pointed out (*Holmes's System*, vol. iii. p. 820) how "pigeon-breast" is one of the effects of the disease, atmospheric pressure bending in the bones that have lost their elasticity and become softened, and causing a projection of the sternum and lateral flattening of the chest.

In the spine a general curving of the whole column is the more usual deformity, "*lordosis*," or anterior projection of the lumbar vertebræ, as a compensating curve, being found when pelvic obliquity is present.

In all cases of rickets Humphry has shown (*Med.-Chir. Trans.*, 1862) that deficiency of growth coexists with deformity, the lower limbs more than the upper indicating this in their proximal segment. In severe cases all the bones are more or less deformed, the *cranium*—often large—presenting a quadrilateral aspect, with sutures widely open till a late period of life, or even subsequently reopening, the bone either remaining thin or subsequently thickening. The periosteum in these cases is also usually thickened, in the flat as well as in the long bones.

The general symptoms of rickets are those of debility, muscular and general weakness of the whole frame gradually passing into that of rickets; dentition is retarded and teeth decay or drop out. Sir W. Jenner lays great stress upon profuse perspiration of the head during the night, a tendency to kick off bedclothes, fetid stools, and general tenderness of surface as constant symptoms of the early stage.

Pathology.—Tomes and De Morgan inform us that a rickety bone has the structural arrangement of normal bone without the earthy salts. Jenner (*Med. Times*, 1860), however, describes an enlargement of the lacunæ generally, the effusion of a red pulpy substance in the cancellous tissue, and a thickening of the periosteum, while Gee (*St. Bart. Rep.*, 1868), Dickinson (*Med.-Chir. Trans.*, 1852), and others have pointed out how the viscera undergo some "albuminoid" changes unlike the waxy or lardaceous disease.

In normal bone there is 37 per cent. of organic and 63 per cent. of inorganic matter. In rickets the proportion is 79 per cent. of organic and 21 per cent. of inorganic matter. Bones that have been solid may become pliable when this disease begins.

Rickets is a curable affection—that is, if taken before it has far advanced; and it is remarkable to what an extent the deformities are remediable under natural processes, and how curved or bent shafts of bone recover their natural shape on taking off downward pressure and improving the general powers of the child. In more severe cases, where the curvature cannot be remedied, the bone consolidates and becomes strengthened by buttresses of bone along the concavity, and, although the stature may be diminished and the limbs deformed, the general powers of the patient may be restored and a sound recovery take place.

Treatment.—The *medical* treatment of rickets should be conducted on reasonable principles—fresh air and abundance of it, simple nutritious food such as may suit the conditions of the digestive organs being essentials; milk and beef tea for young children should be mostly relied upon, and meat in moderation for the older. Cod-liver oil, iron, and quinine are also very valuable drugs. The bowels should be carefully attended to, while all violent purgatives ought to be avoided.

The *surgical* treatment in the early stages is the prevention of deformity, and in the later the remedying of it. By way of prevention, the child should be restrained from any prolonged standing or sitting position; the horizontal posture should be observed as far as possible; exercise should be allowed and followed by rest, the two alternating according to the powers of the patient and the necessities of the case. As the general health and powers improve more liberty may be sanctioned. In spinal cases these obser-

vations are more especially binding, and in them movable couches and spinal chairs are of great service.

Where moderate deformity exists, more particularly in the lower extremities, it is often interesting to observe how, by the above means, the bones recover their normal shape, and children "grow out" of their deformity as their health improves if only the surgeon takes care it is not increased by neglect.

In still worse examples, and where exercise is essential and intermittent rest will not be observed, splints and instruments may be bound to the legs. Two long side-splints reaching to the ground, carefully bound together and removed at night, are as good as any, or an iron splint with joints at the knee and ankle. Some surgeons prefer an outer splint for knock-knee and an inner one for bow legs.

When the curvature of the shafts of the leg bones is very great or acute, Mr. H. March has adopted the plan of forcibly straightening the bones when the patients are under chloroform. He thinks little of the risk of breaking the bone, knowing how rickety bones unite (*St. Barth. Rep.* for 1870). He believes the plan more adapted for acute than for chronic cases. In extreme cases an osteotomy may be performed, or a wedge of bone may be removed from the shaft. I performed this latter operation in 1863 on the leg of a child between four and five years of age, and Mr. Little has more recently repeated the operation with advantage. It should be done only in extreme instances of deformity and when no hope of improvement by other means can be entertained. Osteotomy for this affection is now a common operation.

Acute rickets has been described, but Dr. Barlow in a very able paper (*Med.-Chir. Trans.*, vol. lxvi., 1883) has clearly shown that such cases are a combination of scurvy and rickets, and that they should be called "infantile scurvy," the scurvy being an essential and the rickets a variable element. He carefully analyzes 31 cases. The invasion of the disease may be gradual or abrupt, with more or less swelling of the legs, with pale, tense, shining skin, but *without* increase of heat. There may be some redness of the part and some œdema extending up the thigh. The tenderness on pressure is extreme, so that the child cries even in anticipation of being touched. In severe cases the child moans constantly; there is also some pseudo-paralysis of the affected limbs. When the disease affects the thigh, all the local symptoms will be the same, only higher in the limb. Other bones may become affected simultaneously or by subsequent involvement. In most of the cases there is head-sweating, and in some the bones of the cranium appear thickened near the sutures. In rare cases purpuric symptoms appear.

There is rarely very great increase in bodily temperature, and this seems to turn more upon the tension of the affected bone and soft parts over it than anything else.

In almost all these cases there is sponginess of the gums, and in many stomatitis.

The disease is a dangerous one, no less than 7 out of Barlow's 31 having died.

The *pathological condition* of the affected bones is very marked. The periosteum is separated from the bones, and the shafts of the bones from the epiphyses; a layer of maroon-colored blood-clots surrounds the bone. The bones affected may die in part, but not wholly, as in inflammatory affections. It was this condition that induced Mr. T. Smith, who was the first to record a case of this disease (*Path. Trans.*, 1876), to describe it as one of hemorrhagic periostitis. The periosteum may be thus separated from the cranial or any bone.

There is no reason to believe that syphilis has anything to do with this affection.

The disease tends spontaneously toward recovery under proper treatment.

TREATMENT.—The treatment recommended by Barlow is, *locally*, during the acute stage, wet compresses and avoidance of movement, at a later period careful shampooing and douches; *internally*, the use of raw-meat juice, fresh milk, and orange-juice or of some fresh raw vegetable, and from the first the access of as much free air as is possible.

OSTEITIS DEFORMANS.

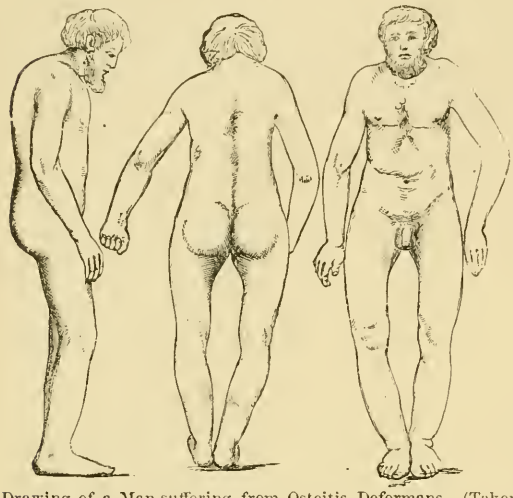
This name has been given by Sir James Paget to a remarkable disease which he has described in papers published in vol. lx. of the *Trans. of the Royal Medical and Chirurgical Society* (1877) and in vol. lxv. (1882). I have recorded in the *Guy's Hosp. Reports* for 1877 a good example of it, and have seen three since.

It begins, writes Paget, in middle age or later, is very slow in progress, may continue for many years without influence on the general health, and gives no other trouble than that which is due to the changes of shape, size, and direction of the diseased bones.

Even when the skull is hugely thickened and all its bones exceedingly altered in structure, the mind remains unaffected.

The disease affects most frequently the long bones of the lower extremities, the clavicles, and the skull, and is usually symmetrical. The bones enlarge and soften, and those bearing weight yield and become unnaturally curved and misshapen, suggesting the proposed name, "osteitis deformans."

Fig. 679.



Drawing of a Man suffering from Osteitis Deformans. (Taken from Author's case. *Guy's Rep.*, 1877. This patient is now (May, 1884) dying. He is blind and bloodless, and can hardly raise his limbs on account of their weight.)

The spine, whether by yielding to the weight of the overgrown skull or by change in its own structures, may sink and seem to shorten, with greatly increased dorsal and lumbar curves; the pelvis may become wide and the necks of the femora become nearly horizontal. But the limbs, however misshapen, remain strong and fit to support the trunk. (*Vide* Fig. 679.)

In its earlier periods, and sometimes through all its course, the disease is attended with pains in the affected bones—pains widely various in severity and variously described as rheumatic, gouty, or neuralgic, not especially nocturnal or periodical. It is unattended with fever. No characteristic conditions of urine or feces have been found in it, nor is it associated with any constitutional disease, unless it be cancer. Three out of the twelve cases recorded by Paget have ended in connection with this affection.

The bones examined after death show the consequences of an inflammation affecting in the skull the whole thickness—in the long bones chiefly the compact structure of their walls, and not only the walls of their shafts, but in a very characteristic manner those of their articular surfaces.

"The changes of structure produced in the earliest periods of the disease have not yet been observed, but it may be believed that they are inflammatory, for the softening is associated with enlargement, with excessive production of imperfectly developed structures, and with increased blood supply.

"Whether inflammation in any degree continues to the last, or whether, after many years of progress, any reparative changes ensue, after the manner of a so-called consecutive hardening, is uncertain."

The disease does not apparently have any shortening influence on first life, for in Sir J. Paget's case it had existed for twenty years, and in my own the man is now sixty-seven, the symptoms having shown themselves about eleven years. The patient is now amaurotic and so feeble that he cannot raise his heavy limbs. He is anæmic, but shows no other signs of disease.

In May, 1877, I saw a second example of this affection in the person of a married lady æt. 54, who, although in the enjoyment of excellent health, was quite unable to walk without crutches, on account of the weight and weakness of her legs. The disease had been gradually coming on for six years, and the pains in the thighs had given her great trouble. When I saw her, she came into my room on crutches and sat down with the arched back so peculiar to this affection; her thigh-bones were enormously thickened and bent; the necks of the femora were horizontal, as proved by the test line of the ilio-femoral triangle (Fig. 569), and the knees were far apart, from the bowing of the legs. The bones of the upper extremity were also clearly enlarged. I could not make out that the cranial bones were involved. The lady informed me that she was at least an inch shorter this year than she was last; the changes in the necks of the femora would, however, account for this fact.

She had had two sisters; one died from cancer of the breast, while the second was an imbecile and had died in an asylum.

This case well supports the observations that have been made.

Sir J. Paget regards the disease as inflammatory. Dr. Goodhart brings forward

another hypothesis. He does not think the term "inflammatory" can be considered as properly descriptive of this disease, partly because to give "inflammation" so wide a meaning as would embrace a general hypertrophy of all the bones as one of its results would be to deprive the term of all significance, and also because it is still less applicable to other diseases allied to the one in question.

Dr. Goodhart considers that hyperostosis is essentially a new growth—or, as he expresses it, a generalized bone tumor—and adduces in support of this view, 1st. The clinical history of the disease; its coexistence with otherwise good health; the absence of pain; its intractability under treatment; its frequent association toward its close with some other form of malignant tumor. 2d. Its peculiar parallelism with molluscum fibrosum and a form of elephantiasis, which is a corresponding disease in the subcutaneous or fibro-cellular connective tissue to this in bone connective tissue. There is certainly a good deal to be said in favor of this view, and, though Sir James Paget does not see his way to adopting it as the more probable, I am, on a review of the whole subject and unfettered by any partiality for a theory of my own, inclined to think with my colleague.

No treatment seems to have the slightest influence on the progress of this affection.

CHAPTER XXXIV.

ON GUNSHOT INJURIES.

"Gunshot injuries," writes Professor Longmore, "are the injuries which result from the action of missiles set in motion by a force which is derived from the ignition of explosive compounds. They comprehend every kind and degree of hurt which is capable of being produced on the human frame by the mechanical impulse of obtuse bodies." He informs us, moreover, that in every hundred casualties there are twenty killed to eighty wounded, and that of the wounded one-third of the cases are severe and two-thirds slight.

The wounds vary much in their character and nature, one caused by a rifle ball differing from that by a cannon ball or shell; and the *direct* effect of a missile upon a part differs from that produced *indirectly* by the scattering of stones or any other hard substance caused by cannon shot or shell. *Gunshot contusions* of tissues, although apparently trivial, are, as in civil life, often associated with severe deep-seated injuries, and superficial wounds apparently unimportant are often attended with or followed by serious accidents. Gunshot wounds are always of the *contused* class; those of civil life, however severe, are rarely, if ever, attended with that complete attrition and displacement, and even total removal of substance, which are so constantly characteristic of wounds produced by gunshots, particularly in those of recent times. Gunshot wounds, moreover, are also prone to be complicated by the introduction into the wound of some foreign body, such as some portion of the soldier's dress pressed into the wound, or some part of the wadding, shot, or shell itself.

It should also be known that "substances of very low degrees of density, such as plugs of tallow, light wood, cork, wads of paper, and others, will serve to inflict penetrating wounds in the softer structures of the body having all the characters of wounds inflicted by denser projectiles if sufficient velocity be impressed upon them. But the necessary force to accomplish this result can only be executed within very limited distances" (Longmore).

"The external distinguishing signs of penetrating gunshot wounds are generally manifest enough. The general dimensions of the opening made by the shot sufficiently show whether it has been made by a small-arm bullet, a large grapeshot, or a still larger gunshot; its shape, whether it has been made by a round projectile, by a fragment of a shell, or an irregular splinter of some secondary missile; while the aspect and condition of the lips of the wound and of the structures immediately surrounding it sufficiently mark it as not being one inflicted by a stabbing or cutting instrument."

Gunshot wounds differ considerably in appearance, these differences depending upon the forms of the missiles causing the injury, and their speed, as well as the part of the body struck and the position of the patient relative to the projectile at the time of injury. When part of the body is carried away by a gunshot at *full speed*, the surface of separa-

tion will present a level yet contused and almost pulpified aspect; when the *speed is less rapid*, the soft parts where the separation has taken place will be more lacerated and the bone comminuted; and when the *speed is spent* or the direction oblique, either the injured parts will be crushed more or less deeply, or, with little or no evidence of external injury, the deeper parts may be irreparably disorganized.

Again, **bullets, when at full speed,** perforate or penetrate; but when at lessened speed, they crush and lacerate. When a gun is discharged *near the* body, the parts around the wound of entrance will be blackened and burned, while the wound of entrance appears as if punched out. When the discharge of the musket takes place *a few inches from the body*, the injured tissues will be more or less scorched, blackened, and studded with grains of unexploded powder, and the wound of entrance large, ragged, and excavated.

Wounds from bullets not at full speed, and fired at a distance of two or three hundred yards, will present an opening the size of the projectile, or possibly smaller, circular in shape, with serrated (inverted), undermined, puckered, and flabby edges; at times, however, a flap of skin is found at the opening.

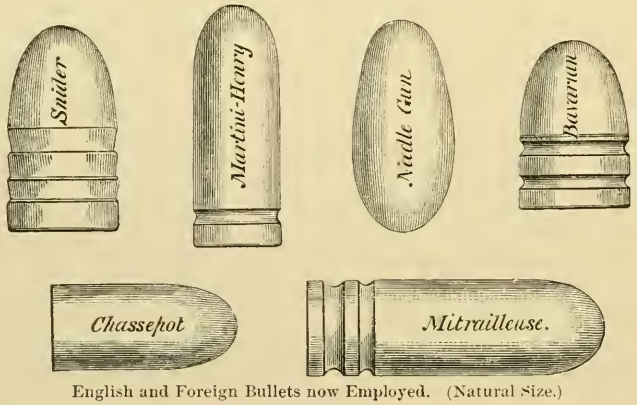
The margin of the opening will appear as if contused, the evidences of bruising fading away into the surrounding tissues.

When the *speed of the bullet is much* diminished, no skin may be carried away, the diminished speed of the missile simply stretching and tearing asunder the tissues to allow of entrance.

When wadding or other foreign substance has been carried into the wound of entrance, this will of necessity be more lacerated and appear larger than it would otherwise be; and the same conditions may be found to exist when a ball enters the body where bone is only covered with thin integument.

In modern warfare, where the rifle bullets are of a cylindro-conoidal form (Fig. 680), soft parts are more readily penetrated and bones more generally split or splintered than

Fig. 680.



English and Foreign Bullets now Employed. (Natural Size.)

was found of old from the impact of round balls. In the late Franco-German war these points were generally observed, and, although the Prussian and Bavarian balls were said to be larger than those of the French, the wounds produced by all were very much alike; if anything, however, the wound from the needle-gun produced the wider tract and larger opening.

Indeed, in the "seton wounds," or wounds penetrating the soft parts alone, of all these balls it was often difficult to make out the wound of entrance from the wound of exit. When they traversed the soft parts alone, they often ran so cleanly through them that only slight suppuration followed and repair was rapid, these modern balls causing less severe lesions of the soft parts than the old spherical balls. Billroth asserts that wounds with split-like exits were remarkable for the amount of suppuration that followed. When bones were struck, no matter what the form of ball, the injury was alike: there was comminution, vertical splintering, and at times almost pulverization. Indeed, in civil life there is nothing like the splintering and comminution of bones seen in wounds from rifle bullets.

The amount of alteration in form which the projectiles assume after striking a bone

is very remarkable, some being completely flattened, others strangely contorted, while many are split.

Dr. Knester of the Augusta Hospital, Berlin, however, has proved by experiment (1874) that the amount of injury the bones and soft parts sustain in a gunshot wound depends much upon the softness or hardness of the bullet, a hard one going through a part and leaving a "seton wound," where a soft one would produce frightful destruction of tissue. He explains this fact by the lead of the softer bullets becoming heated by collision with bone and broken up (not melted). The Martini-Henry bullet is a hard one and made of twelve parts hard lead and one tin. The bullet of the Gras rifle, the weapon of the French army, is likewise hard. The Chassepôt and the others are all made of soft lead, and consequently break up and flatten out against bone, thereby causing large apertures of exit and great laceration of tissue.

When the head of a bone is struck, it is probably comminuted. When bones are not broken, but only bruised, acute periostitis and endostitis are very common, the concussion of the bone being generally so severe as to excite acute action.

With the rifle ball the course is more frequently direct than with that from the old smooth-bored musket. Tortuous courses are even now met with, but less frequently, the weight of the ball and the extreme velocity with which it flies producing a more direct route. It penetrates the soft tissues in a direct line, and when it strikes bone either runs through or splinters it, entering it like a wedge. It will often appear, writes Longmore, that the track of a bullet, even at full speed, is widely removed from a straight line. But it usually is not difficult to reconcile the apparent irregularity in the course the projectile has taken if the many varied positions in which the body and its parts are liable to be placed are called to mind, and if, when making the examination, the surgeon takes care to place the patient in a similar position to that which he was in when struck.

The injury imparted to soft parts by what are called spent balls or *ricochet* shots is the most destructive, and large projectiles *rolling over* the surface of a part or moving at low rates of speed possess a force which will crush all parts, even whole extremities, with which they happen to come in contact, and rupture internal organs in a way peculiar to themselves.

A conical rifle ball, when partially spent, may lodge in a part, either in a bone or some soft tissue. It may take some unusual path and lodge where the surgeon cannot find it or cannot remove it, and under these circumstances it may rest, become encysted, and give but little trouble. But, on the other hand, it may set up a chronic inflammatory action in the part and give rise to local suppuration. Bullets, however, rarely lodge in the soft parts without giving rise to suppuration, although in bones they may do so. Such cases should not, however, induce the surgeon to leave them alone when they can be removed; they should always be extracted if possible, unless they have penetrated any of the great cavities of the body. Billroth speaks very strongly on this point. In all blind tracks in the extremities the finger should be passed into the wound and the foreign body looked for, the external wound being enlarged when needed for this purpose; and in *non-penetrating* wounds of the head, chest, abdomen, and pelvis the same practice may be observed. The removal of the ball as the cause of irritation has not only a beneficial influence on the body of the patient, but it has an equally beneficial influence upon the mind; for as long as the ball remains lost in the tissues the soldier naturally regards it as a serious impediment to his recovery, and there is no effect equal to that caused by its removal. Billroth has found much assistance from Nélaton's sound in doubtful cases, but, as a rule, he says, projectiles that cannot be reached by the fingers can rarely be extracted, the bullet-forceps, even the American, being of small value.

When a part of the body is carried away by a *cannon ball at full speed*, the stump will present a level surface of contused and almost pulpified tissues. The muscles and integument will not have retracted; the extremity of the broken bone will probably stand out, small fragments of bone being scattered over the surface of the wound.

When the same result follows the contact of *a cannon ball the force of which is partially expended*, there will be evidence of more dragging and laceration of the soft parts, more irregularity of the wound, more hanging of the muscles, greater comminution of the bone, and greater injury to the soft parts above the seat of separation, and probably greater splintering of the bone upward.

When the force of the *cannon ball is still less or spent*, there may be no separation of impaired parts, but a general contusion, crushing, or disorganization. In some cases, where the force is oblique, there may be no external evidence of injury, this want of external evidence being too commonly associated with broken bones or severe internal

laceration of viscera or other soft parts. Such cases were formerly set down as due to "wind contusions" or the "brush of a shot," but are now believed to be caused by contusions of nearly-spent cannon balls or glancing blows from some projectile.

Shell wounds, as a rule, produce severe laceration of soft parts; and though they may penetrate tissues, yet they very rarely pass through them.

The wounds produced by rifle balls at full speed at the point of *entrance* are often small, circular, clean cut, and with inverted edges, but at the point of exit large, irregular, and with everted edges.

As the distance from the weapon increases and the velocity of the ball diminishes, so the wound of entrance becomes less circular and regular, larger and more contused, the wound "sometimes consisting of three triangular flaps, which on being lifted up can be made to meet at their apices in the centre of the opening" (Longmore).

When the ball has passed through the part, the wound of exit will probably be larger than the projectile, more irregular, torn, and everted than that of entrance, the subcutaneous fat often projecting. At times, however, with the cylindro-conoidal bullet discharged at full speed, it is difficult to distinguish by its appearance the wound of entrance from that of exit. In the patient's clothing, when the wound of entrance is punctured, that of exit will be lacerated.

The *pain* caused by a gunshot wound depends upon the parts that are injured. In a general way it is not severe, and when so is evanescent. Writers tell us that it is often described as being like the sudden stroke of a cane or the shock of a heavy blow. Sometimes soldiers are unaware of their wounds. When the trunks of nerves are pushed aside and injured, intense pain may be felt, but not locally. Longmore relates the case of an officer who from his sensations thought his arm was broken, but on examination no such injury existed; a ball had passed from right to left through his neck, which probably injured some of the cervical or brachial plexus of nerves, thereby giving rise to his error. More pain is occasionally felt at the wound of exit of a bullet than at that of entrance.

Shock.—"When a large bone is suddenly shattered, a cavity penetrated, an important viscus wounded, or a limb carried away by a round shot, the most prominent symptom is the general perturbation and alarm which in most cases instantaneously supervenes on the injury. This is generally described as the 'shock' of the gunshot wound. The patient trembles and totters, is pale, complains of being faint, perhaps vomits. His features express extreme anxiety and distress. This emotion is in great measure instinctive and seems to be sympathy of the whole frame with the part subjected to serious injury expressed through the nervous system. This shock is more or less persistent according to circumstances. Examples seem to show that it may occasionally be overpowered altogether, even in most severe injuries, by moral and nervous action of another kind, by a state of mental tension; but this can rarely happen when the injury is a vital one. Panic may lead to similar symptoms of shock, although the wound is of a less serious nature. A soldier, having his thoughts carried away from himself, his whole frame stimulated to the utmost height of excitement by the continued scenes and circumstances of the fight, when he feels himself wounded is suddenly recalled to a sense of personal danger; and if he be seized with doubt whether his wound is mortal, depression as low as his excitement was high may immediately follow. This depression will vary in degree according to individual character and intelligence, state of health, and other personal peculiarities; for while, on the one hand, in every action numerous examples occur of men walking to the field hospital for assistance almost unsupported after the loss of an arm or other such severe injury, on the other men whose wounds are slight in proportion are quite overcome and require to be carried.

"As a general rule, however, the graver the injury, the greater and more persistent is the amount of 'shock.' A rifle bullet which splits up a long bone into many longitudinal fragments inflicts a very much more serious injury than the ordinary fracture effected by the ball from a smooth-bore musket, and the constitutional shock bears like proportion. When a portion of one or both of the lower extremities is carried away by a cannon ball, the higher toward the trunk the injury is inflicted, the greater the shock, independent of the loss of blood. When a ball has entered the body, though its course be not otherwise indicated, the continuance of shock is a sufficient evidence that some organ essential to life has been implicated in the injury" (Longmore).

Hemorrhage.—The amount of hemorrhage attending a gunshot wound varies according to the size and situation of the wounded vessels. When large vessels are involved, death is rapid, and such cases do not come under the notice of the army surgeon.

In the cases that come into the surgeon's hands in a general way there has been an attack of hemorrhage directly after the injury, but little more; possibly some oozing, but rarely much, may exist.

When a limb is shot off, there is rarely more bleeding than when it has been torn off by machinery, as seen in civil life. Large vessels, when torn or twisted, seldom bleed. In these cases the plugged pulsating extremity of the lacerated artery will generally be found projecting from the wound.

In the wounds caused by *rifle balls* vessels escape in a marvellous manner, the great resiliency of large vessels and the freedom with which they slip away under pressure from their loose cellular connections allowing a ball to pass along or across their course without wounding them. At times the vessel may be so contused as to become obstructed and obliterated. (*Vide* Prep. at Netley.) Nevertheless, a rifle ball occasionally may directly divide a large artery and cause instantaneous death. In the American war, among the cases of primary gunshot lesions of the arteries that came under treatment, it was found that in most only a portion of the calibre of the vessel had been carried away, and that retraction had thus been prevented.

Secondary hemorrhage is common in gunshot wounds, and is due, probably, as a rule, to the reopening of a wound in a vessel temporarily closed, or to the sloughing of some part of its walls that had been injured. In the *former* case the new tissue that had stopped for a time the flow of blood gives way under some sudden movement or local mechanical force, such as some foreign body in the wound, or breaks down during the suppurative or sloughing process; in the *latter*, the injured coats of the artery are cast off, having been destroyed by some contusion or other violence. In either case the thrombus or clot in the vessel is not sufficiently well formed or organized to resist the force of the blood current from behind. When such a clot organizes, there will, of course, be no bleeding. "The great frequency of secondary hemorrhage has for its chief causes the absence or faultiness of sanitary conditions and the debility of the patient due to privation of nourishing food and to exposure. The means calculated to remove or anticipate such evils will, if applied, be of more value than is the ligature in coping with secondary bleeding after gunshot injury" (MacCormac).

With respect to the treatment of secondary hemorrhage after gunshot wounds, it is in principle similar to that which the civil surgeon follows. Styptics, where large vessels are concerned, are worse than useless. Pressure is applicable only for temporary, not for curative, purposes, and thus the surgeon is driven to cut down upon the wounded artery, to tie or twist both ends, or to apply the same practice to the vessel in its continuity leading to the seat of bleeding when the former operation is too difficult or dangerous. Billroth advocates dealing with the main trunk of the bleeding vessel at an early period of the hemorrhage, and not wasting time by delay. He says that out of 23 cases in which he applied a ligature to large arteries for hemorrhage, death took place in 7 from bleeding on the separation of the ligature, when no clot was found in the vessel; in 12 from hemorrhage and pyæmia, of which no examination was made; and 7 alone recovered.

In the late continental war Stromeyer and MacCormac maintain that the result of such operations was uniformly unfavorable. Out of 12 cases which Stromeyer saw, only 2 recovered. "I think," he says, "we must decide to amputate oftener in cases of secondary hemorrhage."

Possibly a better result might have followed torsion of the arteries, for after such a practice, when bleeding has been arrested, there is nothing to set up fresh mischief in the artery, no foreign body like the ordinary ligature to excite any ulcerative or disorganizing process through which hemorrhage may take place, the thrombus that forms in the vessels after torsion being allowed to go on undisturbed, to organize and become incorporated with the incurved middle arterial coat into one firm organized fibrinous mass. The catgut ligature, however, may possibly be of use in these cases.

Treatment.—In the front of the battlefield little more can be done in the way of treatment of gunshot wounds than the application of the "first field dressing" some pressure or tourniquet to arrest hemorrhage when the vessel cannot be at once secured, some splint or other available support to prevent extra injury being inflicted by movement to the field hospital. The wounds of the soldier must not be manipulated by the surgeons in the front. No examination of the wound is to be made by probe or finger in the battlefield or dressing station. "The one line of treatment to be adopted by the surgeons in the front," writes Professor C. Reyher, "is to occlude the wound provisionally, to lay the wounded part in a suitable position in the litter, and to render it provisionally

immovable;" for the surgeon is to remember that a proper and thorough examination of the wound will take place at the field hospital.

The first field dressing was introduced during the Crimean war in 1853 by Professor Longmore for the first time in any service: "and since that period," writes Longmore, "it has been copied by every civilized power in the world—the principle of every man carrying on his person the means of dressing his wound if he should eventually meet with that calamity."

What the first field dressing should be is not yet determined, but to carry out the practice efficiently it is necessary that the bearer companies should be well organized, and the men of which they should be composed must be expert dressers. The appliances at hand for their use must also be effective, simple, portable, and last, but not least, cheap. That they should be of an antiseptic nature all surgeons will now admit: that they should be absorbent is equally essential. Iodoform, absorbent antiseptic cotton, and gauze and a bandage are probably the three best essentials; and if a piece of protective or waterproof material is added to the list, so much the better. Before examining a wound the clothes that cover it should be carefully looked to, and more particularly the garment next the skin; for "it occasionally happens that a bullet will have sufficient force to penetrate the body to a limited distance, at the same time carrying a portion of the wounded man's shirt before it, while, owing to the yielding nature of the material, it fails to tear a piece out of it. The bullet will then lie, as it were, at the bottom of a pouch of the shirt like the finger in a glove; and when the shirt is taken out, the bullet will be brought away with it." Longmore, in his recent work on gunshot injuries, relates several instances of the kind.

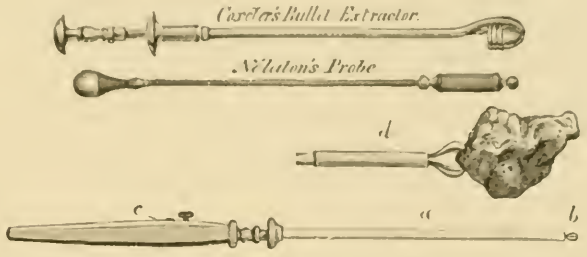
At the *field hospital* the wound should be thoroughly and carefully examined, and to effect this the patient should be placed, when practicable, as near as possible in the position he occupied when he received it. All foreign bodies must be taken away; bleeding vessels ought to be ligatured or twisted; and when necessary the wound should be enlarged for the purpose. No makeshift of pressure or other temporizing means should be employed. When great collapse or "shock" exists, some gentle stimulant may be given. The true condition of parts is to be made out at once and the plan of treatment laid down, soft parts being adjusted, operative interference decided upon when necessary, and right appliances employed. To clean the wound some antiseptic lotion should be used. Iodine lotion made up to strength of a dark sherry color is the most available and as good as any, and in this I have the support of Professor Lister; but carbolic or salicylic acid may be employed. The spray in military, if not in civil, surgery may fairly be said to have been set aside by common consent. Brun, Volkmann, and Billroth amongst German surgeons have all abandoned it, and Sir J. Lister has said, "I do not desire that the spray should be used in military practice: *I believe essentially the same results can be got without it.*" So now all surgeons are on the same platform as to principles, and differ only in points of detail.

By far the best instrument with which to explore a wound is the finger, and for this purpose the external opening through the fascia may always be enlarged. "Probes should seldom or never be used; the finger is by far the best instrument if the wound will admit it" (John Hunter, MS. lect., 1787). "No artificial instrument can give the same amount of information or afford information so precise with regard to the lodgment of foreign bodies and their nature as the surgeon's finger can give. The surgeon should not withdraw the finger until the course the projectile has taken, the injury it has done, the complications of the wound, such as the presence of foreign bodies, and in such a case their kind and situation, have been decided by him; the exploration will then be completed by one operation, and a second insertion of the finger for the purpose, which is always irritating to a patient, will be avoided. The knowledge gained, moreover, will be definite and of special utility in determining the proceedings to be afterward adopted. The exploration is often assisted by pressing the soft parts, especially if the wound be in one of the extremities, from an opposite direction toward the finger end." Sometimes, when a lodged ball cannot otherwise be discovered, it may be found by passing the flat palm of the hand down the limb. "Sometimes," writes Longmore, "it may be detected simply by relaxing the muscular tissues, so as to give a loose and pendulous condition to the parts concerned, and then lightly tossing up the flesh at different points from below with the tips of the fingers. When the finger passes through an opening in fascia or a deep aponeurosis, the track will feel constricted; when through muscles and connective, expanded.

When sufficient information cannot be acquired through the finger, either from the

length of the wound or from its tortuosities, probes must be used. Nélaton's (Fig. 681), with a small ball of porcelain at the end, is good, and so also is Sayre's snake-jointed probe with a like end. Longmore prefers a long silver probe which can be bent to any

Fig. 681.



Lecomte's Stylet-Pince: *a*, Canula moving over *b*, cleft steel rod with closed curettes at end, fixed in handle *c*, the sliding of the canula determining the opening or closing of the curettes; *d*, curettes open grasping bullet.

angle, but speaks highly of Dr. Lecomte's stylet-pince. It responds as an indicator with even more distinctness than the Nélaton probe in all cases in which the test would be of service, while it answers for a variety of other cases in which Nélaton's probe would give no indication at all. By it small particles of the substance imbedded in the tissues can be extracted for examination, and many foreign substances altogether removed.

In gunshot fractures of the shafts of bones which are to be treated conservatively Stromeyer advises that no probing ought to be performed, and in doubtful or in operation cases it ought only to be done just before the operation or under chloroform.

Electric indicators have been employed, and some are most ingenious and possibly valuable, but they are not portable. The appliance of Mr. de Wilde, in which contact with the metal of a ball is notified by the sound of a bell, is particularly taking, and a very useful apparatus has also been made by Messrs. Krohne and Sesemann. Professor Longmore speaks highly of both, but prefers the latter. It is designed to ascertain with absolute certainty if a substance lodged in the body and admitting of being touched with the probe or grasped with the forceps is a bullet, a fragment of a projectile, or other metallic substance. The probe is elastic, and follows the track of any projectile more readily than a stiff probe. In it are concealed two sharp needles, which when a hard body is felt are pushed forward one after the other. This is done by pressing the small buttons on the handles toward the probe. As soon as the two points touch the foreign substance, if it be metal, the electric current passes through the instrument—a fact immediately indicated by the hand on the dial. The hand moves actively toward either the right or the left side. The forceps possess this principal advantage—that they can be also used as a probe, thereby dispensing in many cases with the use of the elastic probe altogether. The extremities are furnished with Assalini's points, with which particles of clothing can be removed if such should be before the projectile. If a foreign body is touched with the forceps, it should be gently grasped between both blades. If it be a bullet or any piece of metallic projectile, the electric current passes through it, and the hand on the dial moves again actively, as described above. It is, of course, necessary to fix the connecting wires of the instrument into the brass heads on each side of the dial. In the drawer below the dial there is a small battery charged with sulphate of mercury. If the charge has become too dry and weak, it should be moistened with a few drops of water, and a few pinches of sulphate of mercury should be added. It is to be observed that the zinc plate touches the platinum points in the trough.

In exceptional and chronic cases, where time has been allowed to pass, these instruments are of greater use than in primary cases.

It need hardly be reasserted that when a ball has penetrated any of the cavities of the body, such as the head, chest, or abdomen, it is not to be sought for on any account.

When a foreign body has been detected, it should be removed; at least, this is the rule. Coxeter's extractor, composed of a scoop for holding and a pin for fixing the bullet, has been highly praised (Fig. 681). Instruments with blades cannot be recommended, as they necessitate the dilatation of the wound.

MacCormac writes, "The bullet forceps I preferred was one with claw points at a right angle with the handle and slightly overlapping, so as to admit of easy ingress. When these catch the bullet, they rarely let it slip. The extraction of bullets, however, requires

skill and patience; much injury may be inflicted on surrounding parts by the incautious use of the bullet forceps."

When, from the smallness of the wound of entrance, force is required, it is better to enlarge than to stretch the wound. When the foreign body rests beneath the skin, an opening through it may be made.

When balls lodge in bone, they should be removed as from soft parts: when they can be raised from their bed by an elevator, such an instrument should be employed. When forceps are wanted for extraction, Luer's "sharp-pointed bullet forceps, which bite into and secure a most firm grasp of the object, will best accomplish the extraction." To aid extraction the gouging away of some part of the bone may be necessary.

As a rule, however, with rifle balls, the bone is splintered; and under these circumstances, when the epiphysis of the bone is involved, excision of the joint is called for when the joints of the upper extremity or the head of the femur is involved, and amputation when the knee and ankle are injured.

After the removal of all foreign bodies from the wound, and when the parts have been cleansed, they should be carefully adjusted, placed at rest in an easy position, and protected by wet or dry lint; union by adhesion is out of all question, and that by granulation alone can take place.

To hermetically seal a wound is not a practice to be generally recommended. Some gentle support by means of a bandage not only gives comfort, but is beneficial.

When suppuration has taken place, the greatest care is needed to prevent burrowing. As soon as abscesses form they should be lanced, and that freely. When the wounds of entrance and exit are opened, the intervening sinus may be syringed with advantage, some medicated lotion such as iodine water, Condy's solution, or carbolic acid, one part to a hundred, being used.

Under all circumstances thorough cleanliness should be observed and good food with tonics and sedatives given, fresh air being allowed to circulate freely around the beds. Stimulants should be administered with great caution, enough only being allowed to assist the digestion of solid food.

Gunshot wounds of soft parts usually suppurate about the third or fourth day, sloughs mostly separate about the tenth or fourteenth, and recovery takes place in five or six weeks, the wound of exit, as a rule, closing before that of entrance.

Gunshot Wounds of the Head.

A gunshot wound of the head received from a rifle ball at full speed produces a *diffused* injury to the skull and its contents; when caused by a spent ball or by a fragment of shell, the injury may be *localized*.

In the former cases the external evidence of injury bears no comparison with the real mischief the patient has sustained: in the latter the external evidence may be greater than the internal. Thus, the experience, says Professor Longmore, of the military surgeon leads him always to hesitate in forming a prognosis, however limited a gunshot injury may appear to be at first observation.

Gunshot injuries are, moreover, specially prone to be followed by diffused meningitis, encephalitis, and the formation of deep-seated abscesses, this proneness to traumatic inflammation being clearly due to the injury the brain itself with its membranes has sustained, for in head injuries with which the civilian is familiar this tendency to traumatic encephalitis bears a direct proportion to the injury of the cranial contents.

Fig. 682.

Wound of Entrance.

Fig. 683.

Wound of Exit.

The opening made into the skull by a pistol ball when at full speed is clean and defined; that of exit, larger and bevelled outward. They are rarely complicated with fissures. When, however, the velocity of the ball is in a manner modified, there may be the same amount of "starring" at the wound as is seen by the civil surgeon.

In military as in civil practice the inner table of the skull is always fractured to a

greater extent than the outer when the ball enters from without (*cf.* Figs. 682, 683, taken from Longmore's article in *Holmes's System*) but the opposite condition exists when the ball passes through the skull on the opposite side of the cranium, the table of the skull corresponding to the point of exit of the ball suffering the most in both cases.

In military as in civil practice the amount of external injury is no indication of the amount of internal mischief. "A spent ball, a fragment of shell, a stone, may cause what appears to be only a contusion of the scalp, yet a fracture may coexist with such a contusion, and a considerable amount of intracranial mischief follow. . . . The amount of bruising obvious to sight and the degree of concussion may have seemed trifling and yet the remote consequences may be serious enough" (Longmore).

Contused gunshot injuries without any external evidence of cranial mischief are at times associated with such intracranial injury as to be followed by a speedy death. "Contusing and glancing shots," says Dr. Neudorfer of Prague in his *Manual of Military Surgery*, "will either occasion fissures, fractures, or depressions or not interfere with the integrity of the skull at all, according to the velocity of the projectile and the elasticity and power of resistance of the bones."

Severe scalp wounds are generally caused by the impact of a projectile at an acute angle. Under such circumstances the bone is often left intact, and little or no injury to the brain results.

At a less acute angle the bone may be bruised, scratched, or furrowed, fissured, starred, or comminuted, and with these several conditions more or less severe brain symptoms may be associated, the gravity of the symptoms depending on the severity of the concussion.

Concussion in military as in civil experience means either a temporary suspension of brain functions, a contusion or laceration of the brain structure, or a more or less severe extravasation of blood upon or into the brain itself, a severe contusion of the skull without fracture being quite capable of producing a fatal laceration of a sinus.

"A simple observation of the injury to the outer table, whether by sight or touch, will by no means necessarily lead to a knowledge of the amount of injury or change of position in the inner table" (Longmore). Indeed, it is quite possible for a piece of the inner table of the skull to be fractured and detached without any fracture of the external taking place. This is illustrated in Figs. 684, 685, taken from the drawing of what is believed to be a unique specimen (2313 A. M. M.), in the United States Museum, published in circular No. 6.

Fig. 684. Fig. 685.

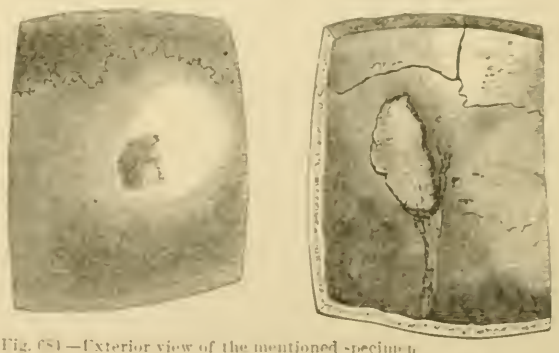


Fig. 684.—Exterior view of the mentioned specimen.
Fig. 685.—Fracture of the vitreous table of the frontal bone without fracture of the external.
(Circular No. 6, Figs. 1 and 7, Washington.)

When the external table has been ploughed off by the projectile, care should be taken not to mistake such an injury for a fracture of both tables with depression.

In military as in civil practice, too, *fissured fractures* are mostly the result of blows by heavy projectiles, and fissures of the inner table without external evidence of the injury occasionally occur.

Comminuted fractures in both military and civil experience are also chiefly local injuries, the force of the ball or blow expending itself on the injured spot.

Wounds complicated with fracture and depressed bone without lodgment of the projectile are most serious. Of 76 cases recorded after the Crimean campaign, 55 proved fatal, and of the 21 survivors, 12 had to be invalided. "The severe concussion of the whole osseous sphere by the stroke of the projectile, the bruising and injury to the bony texture immediately surrounding the spot against which it has directly impinged, as well as the contusion of the external soft parts, so that the wound cannot close by the adhesive process, constitute very important differences between gunshot injuries on the one side and others" (Longmore).

Fractures of the cranium from gunshot wounds are not unfrequently *complicated with the retention of the projectile*. It may be that the ball has been flattened against the bone and lodged in the wound, or it may be that it has been split against the fractured cranium,

one portion entering the skull and the other the integument. Under either circumstance the segment that enters the skull may either lodge between the bone and the dura mater or lacerate the membranes and enter the brain. Longmore gives a case in which there was a fissured fracture with slight depression, but no hole in the skull, where, after death, half the rifle bullet was found in the brain, the hole through which the half bullet had forced admittance having closed as soon as it had entered the skull. He gives, also, another precisely similar, which reflects great credit upon the surgeon, Dr. B. Howard of the United States, in which, from the presence of a single hair protruding from within the broken bone, it was inferred that a solid substance had entered the skull. Trephining was performed, a distorted Minié ball removed, and recovery ensued.

Rifle bullets at the usual speed, however, in the majority of cases enter the cerebral mass, to make their exit, in some instances, at the opposite side of the skull, in others to rest beneath the opposite wall; at times the ball takes a circuitous route. In all death follows, as a rule, no exception to this fact having been reported from the Crimean war.

Treatment.—To do nothing active when death appears imminent is a duty the student has to learn, but in the primary treatment of head injuries in the stage of collapse, in military as in civil practice, there is no more stringent rule than to abstain from interference—to wait and to watch. The patient should be relieved of all unnecessary dress, no tight belts or garment being allowed to interfere with the respiration. He should be placed in the horizontal position; and when moved from necessity, it should be done as gently as possible. When the extremities are cold, extra covering may be applied, and artificial warmth when possible.

As the case develops its surgical treatment ought to be conducted on precisely similar principles to those laid down in former chapters. Practice is to be established on the preventive principle, to ward off intra-cephalic inflammation, perfect quiet, cold applications to the head, and liquid food being the three essentials. Foreign bodies are to be searched after and removed with extreme caution. When they have entered the skull, and still more the brain, all search is forbidden; but when situated at the external orifice, they should be taken away, and the sooner, the better. If a ball be so impacted as to be immovable, the wound in the broken bone may be enlarged to favor its extraction, but no unnecessary interference with the cranium or its contents should be entertained. All foreign bodies in the integuments outside the skull ought to be taken away as soon as discovered.

The opinion of most surgeons is decidedly against the *operation of trephining* in gunshot wounds of the head. When the operation is entertained, it should only be in compound fractures with depression attended with brain symptoms. The experience of the Crimean war, of our own as well as of French surgeons, of the Schleswig-Holstein and Franco-Prussian wars as recorded by Stromeyer, of the Indian war as told us by Dr. Williamson, is, without doubt, decidedly against this operation. In the Crimean campaign the trephine was successfully employed in only 4 out of 28 cases in our own army, and among the French it was for the most part fatal.

The late American war, however, gives us a more favorable result—85 recoveries to 115 deaths; but the report itself states that "the data are not sufficiently complete to admit of fair comparative analysis," so judgment must be withheld.

In compound fracture loose fragments may always be removed. In all penetrating wounds of the skull with lodgment of the projectile operative interference is out of all question.

As a rule, writes MacCormac, "the largest proportion of good results will obtain amongst those cases where the amount of operative surgery has been at a minimum."

Summary.—By way of summary, it may be remembered that cerebral concussion, rupture of one of the cerebral sinuses, and fatal intra-cranial hemorrhage may take place from a gunshot projectile without any external marks of injury, and that a gunshot injury of the head followed by a scalp wound, without any cerebral symptom, may be followed by inflammation of the bone and meningitis.

The vitreous or inner table of the skull may be fissured, depressed, and even detached, without *any fracture* of the external table. The drawings taken from Circular 6 of the War Department at Washington illustrate the fact (Figs. 684, 685), such accident being probably the result of a small projectile striking the cranium very obliquely. Fissure of the internal table may also coexist with a linear fissure of the external table.

A ball may gouge out a portion of the external table of the skull without injuring the cranial contents.

A fragment or the whole of a ball may partially penetrate the skull and fall out or

be retained or pass through it, the wound of exit through the thickness of bone or through the two sides being larger than the wound of entrance.

Penetrating and perforating fractures of the cranium terminate favorably in quite exceptional instances.

Hernia or fungus cerebri may take place after gunshot as after other injuries, and recovery in these cases may occur, the experience of surgeons in the American war clearly showing that this result is more likely to take place without than with compression or operative interference.

Trephining may be undertaken only with a fair prospect of success in local fractures with depression and brain symptoms, loose fragments of bone being always removed in all compound wounds.

Gunshot Wounds of the Chest.

These are returned as 1 in 10 among the officers and 1 in 17 amongst the men in the Crimean war; about 30 per cent of these died; in the American war the mortality was 73 per cent.

Non-penetrating gunshot wounds generally recover, although they are slow in healing, on account of the natural movements of the ribs interrupting the process of repair. They are, moreover, apt to be followed by pleuritis, on account of the frequency of the ball taking a circuitous course beneath the skin round the walls of the chest. When the chest has been severely contused from a spent ball or a heavy fragment of shell, abscesses, or even necrosis of the ribs, are prone to follow the accident; and from the same character of accident, where there is no fracture, the lungs may be injured, this result being likewise met with in young subjects in civil practice when the chest is squeezed. Professor Longmore states that "ecchymosis, or at least congestion of the lung itself, to a partial extent, in all probability follows every non-penetrating gunshot wound of the chest of much severity." The ribs may likewise be broken and driven in, as in the direct blows of civil life.

Penetrating gunshot wounds are generally fatal, scarcely more than one in ten surviving, while death generally results directly from hemorrhage or from the consequences of secondary inflammation of the thoracic organs. The difficulties of diagnosis in these cases are as great as they are in civil practice, especially if the bullet be small and has entered obliquely near the scapula, or if the track of the bullet is covered by sound skin. "It is only," says Longmore, "by a combination of symptoms, rather than by the presence of any one or other symptom, that a lung wound can in many instances be diagnosed." Penetrating wounds with lodgment of the ball are more fatal than perforating wounds, and a fracture of the rib at the wound of entry renders a penetrating wound more dangerous. When the lung has been wounded by a penetrating shot, shock, collapse, escape of air, hemorrhage from the external wound and from the lung, hæmothorax, and dyspnœa are characteristic symptoms. The *shock* is, however, frequently less in penetrating than in non-penetrating wounds when the latter are attended with general concussion. It is remarkable that a lung may at times be completely traversed by a ball and beyond the hæmoptysis and dyspnœa of the first few days be followed by only the most trivial symptoms.

External bleeding in chest injuries is also said to be more commonly due to laceration of an intercostal or the internal mammary artery than to a wounded lung.

Internal bleeding is the chief cause of death, but the surgeon has no means at his disposal to make out the exact source of the hemorrhage. A gush of blood from the mouth indicates the opening of a large vessel, but in more chronic cases the sources of the bleeding may be pulmonary or parietal. "The situation of the wound of entrance or the course the ball has taken, inferred from the relative positions of the wounds of entrance and exit, will greatly help to determine the probable site of the bleeding, and to some extent its probable degree of gravity. Internal bleeding from a wounded intercostal artery is very rare."

Gunshot wounds of the heart are always fatal, although not always immediately. In a case recorded in Circular No. 3 of the War Department at Washington the patient survived fifty hours, the pistol ball having wounded the right auricle.

Treatment.—To arrest hemorrhage, to remove fragments of bone or foreign bodies, and to do nothing that can interfere with nature's reparative processes, are the three great principles of practice to be observed. They are, indeed, precisely similar to those the civil surgeon follows. In bleeding from an intercostal artery the best plan is to plug

the opening; at least, so says Professor Longmore. This may be done in the following way: "A large piece of linen is laid upon that part of the chest in which the wound is placed, and the middle portion of this linen is pressed into the wound by the finger, so as to form a kind of pouch. This pouch is then distended by sponge or lint pushed into it until the pressure arrests the bleeding; on stretching out the corners of the cloth the pressure of the plug will be increased."

If the wound is not attended with hemorrhage, it should be cleaned and lightly closed, the side being strapped up to restrain movement. Hermetically sealing gunshot wounds of the chest is reprehensible. The patient should be laid on the wounded side with the wound downward, to allow of the escape of discharges.

In all other respects the treatment of gunshot wounds is similar to that of others, and the remarks already made are applicable to them. Venesection is less commonly employed now than it was by the surgeons of the Peninsular war, and in the American war appears to have been abandoned. The dangers of inflammation of the contents of the chest are the chief source of the surgeon's anxiety, and his aim ought to be to prevent them if possible, and when present to check them. Hemorrhage should be treated by the application of cold, perfect rest, and the administration of opium. When empyema follows as a secondary result, a free outlet may be made for the accumulated fluid.

Gunshot Wounds of the Abdomen.

These are mostly penetrating, and non-penetrating wounds are often associated with some injury of the abdominal viscera. Longmore informs us that in the Crimean campaign, out of 115 non-penetrating wounds and contusions, 22 deaths occurred, these cases including those of injured viscera. When death follows a non-penetrating wound, it is, as a rule, from sloughing of the abdominal walls.

Penetrating gunshot abdominal wounds are generally fatal, 9 out of 10 of the Crimean cases, French and English, having been so recorded. In the American campaign the mortality was 74 per cent. Shock is always very great, and collapse from hemorrhage the most striking symptom. This is, indeed, says Longmore, "sometimes the only symptom which will enable the surgeon to diagnose that the viscera are perforated. The mind remains clear, but the prostration, oppressive anxiety, and restlessness are intense. Should life be prolonged, signs of peritonitis will soon appear.

In musket-shot wounds, it is exceptional for any of the abdominal contents to escape from the opening; but when they do, the nature of the wounded viscus will be indicated. The swelling of the margins of the wound accounts for this fact.

Wounds of the *liver* are attended with a large mortality and are always complicated. Shock and hemorrhage are the usual immediate causes of death; but when life is prolonged, peritonitis. Longmore saw only 1 case of recovery in the Crimea, while Dr. Otis records 4 recoveries in America out of 32 cases of this form of injury. In Circular No. 3 of the War Department at Washington, 4 cases of recovery out of 15 from this injury are recorded, and in 1 the gall-bladder was wounded. Wounds of the *spleen* are almost always fatal from hemorrhage, and are generally complicated with other injuries.

Gunshot wounds of the *stomach* are not always fatal. They are made out to exist when the contents of the organ escape externally, or when, from the extent of wound, the viscus can be seen. They are always associated with vomiting of blood. Hennen records two good cases of recovery which occurred at Waterloo, and the well-known American case of Alexis St. Martin, reported by Beaumont, is another. Dr. Peters of the United States army has also reported a case that occurred in the American war. Guthrie and Cooper gives nine or ten others.

Treatment.—When the wound is incised, it should be stitched up. Opium should be administered, with nutrient enemata. Nothing should be given by the mouth for some days.

Gunshot wounds of the intestines are not necessarily fatal, although instances of recovery are rare. Wounds of the large are not so bad as wounds of the small intestines. Hemorrhage, and, if not, peritonitis, is the usual cause of death. Longmore relates one case in which recovery took place. Dr. Hamilton of New York (1865) quotes eight cases of fecal fistula which terminated in recovery by natural processes, all having taken place in the late American war, and in the older writers many more might be found. Dr. Habershon has recorded a most interesting case of gunshot wound of the colon through the right loin, the patient dying four years subsequently from albuminuria (*Guy's Reports*, 1859).

TREATMENT.—Absolute quiet is the most essential point to be observed in these as in all other cases of abdominal injuries. The recumbent position should be enforced and maintained under all circumstances. Opium or morphia should also be given in repeated doses, no drug having a better influence in peritoneal inflammation. Absolute cleanliness of the wound should also be observed, but there should be no strapping or closing of the orifice. Simple nutritious food may be allowed, and as the case progresses solids may gradually be taken.

Fecal fistula appear to have a tendency to close by themselves. In the American cases they gave, in general, but little trouble in their management (Circ. No. 6, S. G. O., 1865).

With regard to exploring the track of the wound, the surgeon should never forget, says Lidell (*American Quart.*, 1867), "that in the management of these cases Art, to be useful, must be the servant of Nature, and must seek to do good by assisting her mistress in the efforts to repair, and not by the introduction of new and violent measures which are liable to aggravate the original injury." He believes that neither the finger nor any instrument should be used for exploratory purposes, except in special cases. Dr. Otis, however, in Circular No. 3 of the War Department at Washington, issued in 1871 (p. 87), says that "the mortality of these cases is so great as to furnish an additional argument in behalf of Legouest's proposition to incise the abdominal walls and explore the track of the projectile in certain penetrating wounds. Thus only can the patient exchange the probability of inevitable death for the possibility of recovery, either through the prevention of extravasation by enterorrhaphy or the bringing of the wounded viscus into apposition with the abdominal walls. For one, I am free to assert that where there is evidence that internal hemorrhage or fecal extravasation is going on, what may be termed the 'ostrich plan' of giving opium and making the patient comfortable should be abandoned; and I believe that prejudices similar to those that ovariotomy has successfully overcome in the last quarter of a century will be dispelled by the results of exploratory incisions in gunshot wounds of the abdomen before many years have elapsed."

Gunshot Wounds of the Bladder

do not appear to be so fatal as the cases of ruptured bladder met with in civil life. Lidell reports two such cases where a good recovery followed, the projectile in both having passed completely through the organ. Guthrie has related six, in all of which recovery took place. MacCormac records a case in which the ball passed through the rectum and bladder, the feces for a time passing through the posterior opening and the urine through the anterior. Both wounds closed by natural processes in seventeen days. In all of these the urine escaped externally through the wound made by the projectile, and thus prevented fatal peritonitis from taking place. Such instances as these indicate the proper practice to be pursued in all cases of ruptured bladder—viz., cystotomy, as for lateral lithotomy. When foreign bodies have been carried into the bladder, they should be removed, as a ball may remain in the bladder and become the nucleus of a calculus. Guthrie, Hennen, Cheselden, and Garengeot have given such cases, and Ballingall has collected 19. In Circular No. 3 of the War Department at Washington 3 cases are recorded in which calculi were removed which had formed on bullets, 1 where a stone had concreted upon an arrow-head, and 1 on necrosed bone.

Gunshot Wounds of the Face

are serious from the fact that they are so frequently followed by secondary hemorrhage; and, as the deep vessels are usually its source, the difficulties of controlling it are always great. When this complication does not destroy life, good recoveries take place, wounds of the face always healing kindly and with little scar. When there is much loss of tissue, some secondary plastic operation may be required, and many are the instances of success following this practice.

Gunshot Wounds of the Neck

are serious according to the nature of the parts involved. When the large vessels and nerves are injured, a fatal result generally takes place; and when the larynx or trachea is implicated, the risks of suffocation are great—not only from the direct result of the injury, but from secondary œdema; when this latter complication occurs, tracheotomy

should at once be performed. Wounds of the neck are very liable to be followed by septicæmia.

Wounds involving *the vertebræ* are usually fatal, those cases alone recovering where the spinous or transverse processes are the parts injured.

GUNSHOT WOUNDS OF THE EXTREMITIES

include flesh wounds and contusions, fractures which are rarely simple and compound fractures, wounds of joints and compound fractures into joints.

All these may be complicated with some injury to the vessels and nerves of the part and the lodgment of foreign bodies or projectiles. Gunshot flesh wounds usually do well unless complicated with lesions of the vessels and nerves.

Fractures from Gunshot Wounds

are sometimes simple, but more commonly compound. When *simple*, they are generally caused by blows from spent balls or other projectiles, the bones usually being split or comminuted and contused, not rarely split vertically into a neighboring joint, the soft parts equally suffering. When *compound*, the same comminution and splintering of the bone is commonly present, associated with other complications, such as severe laceration of the soft parts, involving arteries, veins, or nerves, with their attendant dangers, lodgment of fragments or the whole of the foreign body in the bone or soft parts, and some joint complication from the splitting of the bone into the joint or from direct injury to the joint.

Military surgeons, however, writes Professor Longmore (in *Holmes's System*), meet with cases of partial fracture: "1. Removal of portion of a bone by the projectile making a furrow in its passage across its surface, grooving it. 2. Removal by splintering off longitudinal fragments from the external cylindrical part of a bone. 3. Removal of part of the bone by completely punching out a portion, thus leaving a hole through the entire substance of the bone. 4. Partial fracture by driving inward part of the external cylinder and causing the fragment to lodge in the cancellated structure, with or without lodgment of the projectile."

Of complete fractures, the peculiarity consists in the comminution and vertical splintering of the bone, and of the complete removal of some part of the shaft of the bone, the term "resecting fractures" being applied to such. One curious fact occasionally produced by the heavy conoidal ball is noticed in Circular No. 6 of the War Department at Washington, in which the bone is fissured and comminuted, though less than is common, at the point at which the ball impinges, while at two or three inches above or below this point a nearly transverse fracture of the shaft is produced. In some of the specimens the transverse fracture is not connected by fissures with the fracture produced by the ball. These injuries, probably, are due to balls fired at short ranges.

When conoidal bullets, writes Longmore, happen to strike on or below the trochanters of the femur, they usually leave the head and neck of the bone intact, but cause fissures, which often extend to a long distance down the shaft; when they pierce the head of the bone, all the parts below usually escape fracture; when the neck is perforated, the fracture generally extends both upward and downward. The same rule holds good with regard to the upper extremity of the humerus, although not in so marked a manner.

In all these fractures, from the comminution of the fragments and the concussion the bone has sustained, osteomyelitis and septicæmia are liable to occur, as pointed out in 1860 by Jules Roux of Toulon (*Bulletin de l'Académie Impériale de Médecine*), and by Longmore (*Med.-Chir. Trans.*, 1865). J. A. Lidell showed that gunshot contusions of long bones are more fatal from this cause than comminuted gunshot fractures (*American Journal*, vol. xlix.).

Fractures of the lower extremity are more liable to be followed by such blood poisoning than those of the upper, the susceptibility being much determined by the size of the venous canals; the larger and more numerous the veins of a part, the greater the danger of septicæmia.

In gunshot wounds of the pelvic bones Stromeyer believes the liability to pyæmia to be very great, and that cold and exposure favor its development.

Gunshot Fractures of the Upper Extremity

are far less fatal than those of the lower. "Unless the bone be extensively injured by a massive projectile or longitudinal comminution exists to a great extent, especially if also involving a joint, or the state of the patient's health be very unfavorable, attempts should always be made to save the limb" (Longmore).

Treatment.—When the bone is much splintered, an examination by the finger for foreign bodies or detached pieces of bone should be made and their removal effected. Sharp points of projecting spiculæ should be sawn off, the most dependent wound being extended when necessary, or a fresh incision made for the purpose in a dependent position when only one wound exists, the case being then treated as an ordinary compound fracture.

If the shoulder and elbow-joint be opened and the condition of the soft parts, vessels, etc., is not such as to necessitate amputation, excision of the joint should be performed, the experience of the American war, as of all recent campaigns, very strongly indicating this.

Gunshot wounds of the wrist too often demand amputation; excision is not expedient, but where the major operation is not imperatively demanded attempts to save the limb should be made.

The same remarks apply to injuries to the fingers and hand, and only such portions as are irreparably damaged should be removed; for the value of a piece of thumb and one finger, of whatever kind, is hardly to be overestimated, and every effort should be made to preserve whatever parts can possibly be saved.

Gunshot Fractures of the Lower Extremity

are far more grave accidents than those of the upper. Longmore lays it down as a general rule that ordinary fractures below the knee from rifle balls should *never cause* primary amputation, while, excepting in certain special cases, in fracture above the knee amputation is held by most military surgeons *to be a necessary measure.*

The special cases are gunshot fractures of the upper third of the femur, especially if it be doubtful whether the hip-joint is implicated or not, as in these the danger attending amputation is so great that the question is still open whether the safety of the patient is best consulted by excision of the injured portion of the femur, by removal of detached fragments and trusting to natural effects for union, or by resorting to amputation.

The decision of the surgeon must generally rest upon the extent of injury to the soft parts, the age and the condition of the patient, and the surrounding circumstances. If the femoral artery and vein have been divided, any attempt to preserve the limb will certainly prove fatal.

Amputation at the hip-joint for gunshot wounds is generally fatal—so fatal, indeed, that it ought to be undertaken only when the lower limb is so mutilated as to render it a necessity or when the great vessels have been injured. When any doubt exists as to the probability of saving the limb, the operation should be postponed, and undertaken, if necessary, as a secondary amputation.

The experience of all British and continental surgeons fairly endorses Longmore's conclusions—that while in gunshot fractures of the thigh the propriety of practising conservatism in the upper third is clearly indicated, amputation is the safest practice in gunshot fractures of the middle and lower third.

M. Legouest, in an essay published in the *Mem. of the Society of Surgeons of Paris*, believes that amputation at the hip-joint should be reserved for compound fractures complicated with injuries to the great vessels, and he advocates the postponement of the operation as long as possible.

In **gunshot fracture of the head of the femur,** where the soft parts are not greatly injured or the bone comminuted, *excision* of the bone may be performed, the only case of recovery in the American war from such an injury being where this practice was adopted. In Circular No. 3 two such successful cases are recorded out of three, and they induce Dr. Otis to "add that these instances must place excision at the hip for gunshot injury amongst the established operations of surgery." Out of eighty-seven excisions at the hip for injury in America, eight recovered.

In **fracture of the thigh** the evil of transporting a patient is so great that Stromeyer says, "I have during the last campaign lived to see what I expressed a desire for some years ago when I wrote, 'Above all things it appears to me to be necessary that

cases of gunshot fracture of the thigh should not be transported to a distance, but should be carried on a stretcher to the nearest house and the treatment carried out there.'" He speaks most highly of the conservative treatment of all gunshot fractures. When operation is called for, primary measures should always be preferred for both amputation and excision.

In **fracture of the leg** conservatism has even a better chance—that is, where the shaft of the bone alone is implicated; for when the knee is involved, amputation is generally held to be the rule of treatment. Excision should not be entertained, the results of experience condemning the attempt. Langenbeck recommends conservative treatment in gunshot wounds of the knee, amputation being alone required when the soft parts are severely injured and the bones shattered. He also lays the greatest stress upon the necessity of fixing the limb in some immovable apparatus from the moment of the injury to its cure (the plaster-of-Paris splint being preferred), coupled with the application of ice to the part. In gunshot fracture of the shaft of the leg bones not involving joints the same rules of practice are applicable as have been laid down for the treatment of fracture of the humerus, etc.

In gunshot wounds involving the **ankle-joint** amputation is the best practice. In exceptional instances where the injury is slight—that is, where the bone is simply split into the joint—an attempt to save the limb may be justifiable. Excision as a primary operation is not desirable; as a secondary one, where an attempt to save the limb has been made and failed, Langenbeck's experience is in favor of excision, nine out of eleven cases in which he did it after the Bohemian war having recovered, but to obtain this result he asserts that the complete immobility of the parts involved by means of the plaster-of-Paris splint or one of its congeners is indispensable.

With respect to **amputation in gunshot fractures,** every surgeon since Guthrie's time believes that the *primary* should, as a rule, be preferred to the secondary. This primary amputation should also be performed as soon after the accident as possible. There is no necessity to wait for the effects of the shock of the accident to pass away, and unless the collapse be very severe the hand of the surgeon need not be stayed. When, however, the collapse is great, some little delay had better be observed, for it is then more than probable that some internal injury or other complication exists to prevent reaction.

Chloroform or any other anæsthetic may be used in military as freely as in civil practice. It has a powerful influence in preventing shock and allowing prolonged or double operations to be performed which could not otherwise be undertaken—at least, without extra risk. In military practice it should be remembered that a limb must often be sacrificed when in civil practice it might be saved, and that amputation is often substituted for excision on account of the impossibility of giving the part the necessary amount of absolute rest and the patient the attention that can be found only in a civil hospital, "for when active operations are proceeding and it is necessary to carry the wounded to any distance, the advantage of early removal of shattered limbs is obvious, especially when means of rendering the limbs immovable during the transport are defective or the transport itself has to be conducted over rough roads or in unsuitable vehicles, and the hopes of success from conservative treatment are thereby reduced almost to zero" (Longmore).

Dr. Gordon, the British commissioner accredited to the French army in the late war between France and Prussia, informs us that the conclusions the bulk of surgeons arrived at as regards amputation were that it was more suited than excision or resection when its subject had to be carried on with the army; that excision and resection were much more likely to be successful when practised in the upper than in the lower extremity; that excision of the knee as a substitute for amputation in case of gunshot wounds of that articulation has sadly failed; that the practice of conservative surgery in stationary hospitals furnishes no criterion of its suitability in movable hospitals, its requirements involving such attention from the surgeon as can alone be fully carried out when there are comparatively few cases of severity to attend to; and that in many cases where the limbs are saved they are relatively of little use.

MacCormac urges that the mortality after primary is so very much smaller than that attendant on secondary amputation that this point cannot be too strongly insisted upon.

The *Surgical History of the American War*, as prepared by the late Surgeon Otis and published by the American government, is a mine of practical information on gunshot and other injuries incident to warfare.

OSTEOTOMY.

When, in 1870, Mr. W. Adams reported his first successful case of subcutaneous division of the neck of the femur for the cure of a deformity the result of some old hip disease, he introduced to the notice of British surgeons an operation of great value and of wide application, and which, under the name of "osteotomy," has already won a high position in practical surgery. Mr. Adams, however, did not suggest the operation, but followed Langenbeck, who in the winter of 1852 first performed it, and later on applied it to cases of rachitic deformity of the legs and others. At the present time Adams's operation, as first described or with certain slight modifications, is the one employed for the rectification of deformities in most hip cases. In Ogston's and Macewen's operation for the cure of bad cases of genu valgum osteotomy is fully recognized. In the division of curved or bent bones the result of rickets it is constantly being performed, and as a means of correcting the deformities due to badly united fractures or unreduced dislocations it has a bright future.

Indeed, experience has fairly proved that bones deformed by accident or disease may be divided by the saw or chisel through a small skin wound with an amount of safety which is somewhat startling, and that the operation has apparently attached to it a smaller number of risks than many others of a so-called minor character.

Whether the saw or chisel be used is a matter of small importance, so long as either instrument is used carefully. For my own part, I prefer the saw; it was the one I originally employed in my early hip cases, and I have greater confidence in cleanly dividing the bone I approach with the saw than with the chisel. When the saw is inapplicable, as in the division of bones above the ankle for badly united fractures, the chisel may be employed.

The wound must be kept clean during the operation, and for this purpose I hold with my left hand, when grasping the bone operated upon, a sponge fairly filled with warm iodine water, but carbolic lotion may be used instead. When the bone is divided and the limb brought into the required position, the wound may be closed and covered with iodoform or carbolic gauze. The limb should then be at once fixed by some immovable splint, such as Croft's or other plaster-of-Paris bandage, in the position in which it is eventually to be brought.

In the majority of cases repair goes on quietly and quickly, and in five or six weeks the required result is brought about. In exceptional cases suppuration has taken place in the line of bone section, and in a still fewer number one of the accidents appertaining to wounds, however trivial, has brought about bad results. Accidents to deep vessels have likewise been recorded, and in one a spiculum of the diseased bone perforated a large artery and necessitated a series of operative proceedings which ended sadly. Still, all these evil results are very exceptional. They should, however, be remembered as warnings against surgeons being too strong in their assertions of the absolute safety of the measure under consideration, and to remind them that interference with such tissues as living flesh, bone, and blood has its own dangers and risks, which exist in spite of the skill which may be brought to bear upon the case by the operating surgeon or the theory under which the treatment of the wound may be carried out.

Osteotomy as an extension of subcutaneous surgery to bones is a great advance, and if not practised rashly is a valuable operation. Its special application to special cases has received consideration in former chapters.

BONE-SETTING.

Bone-setters have acquired a position in this country, and the fact must be accepted as conclusive evidence that surgeons have in a manner failed to give to the public the relief that has unquestionably been given by their unqualified and so-called ignorant fellow-workers, rather than as an additional testimony to the acknowledged preference which a large number of the public undoubtedly have for the strong assertions and professed power of charlatans and quacks over the calmer views and less dogmatic dicta of the scientific school.

With this feeling I propose to consider briefly where it is that our faults lie and how it is that they are to be remedied. And, first of all, where is it that surgeons have failed? That the failure belongs more to the surgery of the joints than anywhere else is a truism, for the favorite expression of the bone-setter that he has "put in" what was "out" before is a well-known phrase, and that the process of putting in is some sudden

forcible movement of the joint in the way it should, but would not, go, with free movements of the joint in all possible directions, is a well-recognized form of practice.

The conclusion therefore is tolerably clear that where success follows the bone-setter's effort movement is given to a joint in which little or but impaired movement previously existed, and that this is effected by the breaking down of adhesions, either in the joint itself or in the muscles and soft parts about the joint. In fact, his operation consists in the sudden rupture or freedom of parts that forbade the free movement of the articulation.

Nothing need be said about the clicks, snaps, and sounds which are made to tickle the ears of the patients and to make them understand how something that was out went into place, since these are only "tricks of the trade," adjuncts to the empiric's art, employed to secure the patient's belief in his assertions.

In one case a tendon, a rigid muscle, or a nerve is doubtless freed where it was before fixed. In another an old adhesion which gave pain when extended is suddenly snapped. In a third possibly some displaced tissue or slipped tendon is restored to its right place, some fibro-cartilage in a joint is replaced. In rarer cases, after fracture, some osseous union is broken through. In all, however, the result is the same: movement is given where before it did not exist or free movement is acquired where painful movement was previously experienced.

The experience of general surgeons could produce ample proof that there are evils connected with the practice. The present writer has seen many ill results. In one an impacted fracture of the neck of the femur undergoing natural repair was ruthlessly broken up and comminuted and the man rendered an irremediable cripple. In another an elbow which had been dislocated and reduced, and in which some stiffness followed, was hoplessly disorganized by rough and needless manipulation. A hip-joint undergoing a good cure with anchylosis, having been broken down, underwent suppuration, which ended in the death of a valued life which would otherwise have been spared.

These, and more than these, speaking cases illustrate the dangers of a practice which has much good in it if rightly directed, and likewise much evil if wrongly and recklessly undertaken, especially if undertaken without knowledge of or care for a scientific diagnosis before treatment.

It is, however, the surgeon's duty, in these as in all other cases, to seize the good and avoid the evils of a practice which—doubtless by chance—at times does much good, and there is no doubt that for fear of doing harm surgeons often let the good go, and thus allow their patients to pass into the hands of charlatans.

The surgeon ought, therefore, in cases of stiff joint, more particularly after *sprains* and *injuries*, when all signs of overaction or inflammation have subsided, gave an anæsthetic and employ sudden forcible movement. He ought to guard against stiff joints in the treatment of those injuries by employing passive movements earlier in the progress of the case than he has been wont to do. In many obscure affections of joints and limbs the result of twists, sprains, or injuries, he ought, for diagnostic as well as curative purposes, to give an anæsthetic and so to manipulate the joint and limb as to discover if possible, and to dislodge or replace if present, what evidently interferes with motion at the time and may continue to do so in the future.

In cases of limited disease of the joints there is no doubt, also, that much may be done to prevent stiffness and to correct it when present, but in such cases a great appreciation of the changes in and about the joint which preceded the stage of stiffness is all-important—first, as a guide to know what prospects there may be of giving the movement that is so desired; and secondly as to the risks that must be run to obtain it.

When the anchylosis or stiffness has been brought about by a long series of joint changes, any attempt to break down united parts must of necessity be difficult, futile, and dangerous in the extreme.

When it is probably due to some peri-articular inflammation, the prospects of obtaining a good result are better. At the same time, it is to be admitted that the ultimate results of breaking down adhesions about or in joints that are the result of disease with the view of giving movement are not satisfactory. Movement for a time may be secured, but the state of immobility is again soon reached.

On the whole, by way of summary, it may be said that the stiffness of a joint following a sprain or injury may generally be treated with success by rapid manipulation, followed up by passive movements through the entire range of joint movements, whereas the stiffness of a joint due to disease can rarely be so treated without harm.

But in no case should forced flexion or movement be employed when any local signs of inflammation are present.

CHAPTER XXXV.

ANÆSTHETICS.

General Remarks.

When Sir H. Davy's attention was drawn in 1798 to Priestley's nitrous oxide gas by Dr. Mitchell's theory that this gas "was the principle of contagion and capable of producing the most terrible effects when respired by animals in the minutest quantities, or even when applied to the skin or muscular fibre," and when he with Southey, the then poet-laureate, and Coleridge, the philosopher, inhaled it with sufficient frequency "to establish the fact that the gas possesses an intoxicating quality to which the enthusiasm of persons submitting to its operation has imparted a character of extravagance wholly inconsistent with truth" (*Life of Davy*, by Paris, 1831)—he little thought he was then laying the basis of experimental investigations that were to form an epoch in the history of the world—or, rather, of mankind—and to end in the introduction into practice of a new power, which, being of inestimable value to the general public, is of nearly equal value to the medical profession, and has been the means of revolutionizing surgery to an extent of which few are aware; for the "most terrible effects" with which this gas was credited have been transformed into the beneficial effects brought about by anæsthetics.

In the present work I have neither space nor inclination to go fully into the history of the subject. To the works of Snow, Sir James Simpson, Sansom, Druitt, Holmes, Dr. Marion Sims, and MM. Perrin and Lallemand I must refer the reader for full particulars on this subject. I shall content myself by recording the fact that Dr. Crawford W. Long of Athens, Georgia, was the first surgeon who, in March, 1842, performed a surgical operation while the patient was completely anæsthetized by the inhalation of sulphuric ether. Dr. Marion Sims (*Virginia Medical Monthly*, May, 1877) remarks "that the honor of the first public and authentic trial of surgical anæsthesia by the aid of means newly discovered belongs to an entirely obscure dentist, Horace Wells of Hartford, Connecticut" (M. Perrin), this dentist having employed Davy's nitrous oxide gas in dentistry in 1844 with an excellent result. In 1846, Morton, Wells's late partner, introduced into practice at the Massachusetts Hospital the use of sulphuric ether, probably on the suggestion of Dr. Jackson. In 1847 our own Lawrence of St. Bartholomew's, on the suggestion of a student—Mr. Furnell, now principal of Madras Medical College—used chloric ether for the same purpose (*Holmes's Syst.*, vol. v. 2d ed), and in the autumn of the same year Sir James Simpson gave to the profession the active principle of the chloric of ether, the chloroform, on the suggestion of Mr. Waldie of Liverpool, and since then this drug or ether, separately or combined, has been in general use.

Other anæsthetics, however, have been introduced, the bichloride of methylene being the most popular.

How anæsthetics act upon the body is not yet determined, although it is tolerably certain that the ultimate result is absolute paralysis of the nerve centres, cerebral and spinal. To this end a patient passes through, *first*, a stage of cerebral excitement; *next*, cerebral insensibility and loss of sensation; *thirdly*, loss of voluntary motion; and *lastly*, loss of reflex action, the brain losing its power before the spinal cord, absolute paralysis and anæsthesia existing only when both nerve centres are completely under the influence of the inhaled drug, the nerve supply of the respiratory and circulatory systems alone excepted. Indeed, it is upon this fact that the practical value of all anæsthetics is based, the surgeon aiming at producing paralysis of the muscles of the trunk and extremities only, and not those of the respiratory or circulatory systems. In a general way, there is a wide interval between the two effects. In exceptional instances this interval is abridged; in such the heart and respiratory system suddenly become affected, and it is under these circumstances that sudden death takes place.

Chloroform, like many other drugs, does not act alike in all individuals, some being very susceptible to its influence, whilst others are the reverse. Like all anæsthetics, it at first increases the force of the heart's action, although this effect is slight and transient, the heart acting with less than its natural force when complete anæsthesia is produced. When a patient is brought quickly under the influence of an anæsthetic, the heart's action may be suddenly arrested. Brown-Séquard believing that under such circumstances

"it is by the reflex influence due to the sudden irritation of the branches of the par vagum in the lungs that chloroform has killed in the very rare cases in which the heart's action had been stopped before the respiration" (*Lect. on Phys. of Nerve System*).

Moderate doses of chloroform tend to weaken the heart's action after their first stimulating effects have passed away, the respiratory act usually ceasing before the circulatory when death is the result. Thus, danger increases with the degree of stupor produced.

Ether is said not to depress the action of the heart to the same extent as chloroform. Of late it has grown rapidly into favor, and it is said by its advocates to be more safe than any other anæsthetic. It should be given with sufficient freedom to bring the patient under its influence before the blood becomes saturated.

When the upper eyelid can be raised without muscular resistance and no muscular contraction is caused by touching the cornea, the patient is, as a rule, sufficiently under the influence of the anæsthetic for surgical purposes.

Respiration generally, but not invariably, ceases before the action of the heart, and death may be due either to the failure of the heart's action or to that of the respiratory function.

After death all the cavities of the heart are distended, the cases in which the left side is empty being only exceptional. Chloroform is more commonly fatal in the struggling stage than in any other.

Billroth asserts "that during the stage of excitement violent muscular efforts may give rise to apoplexy, especially in individuals with disease of the heart, rigid arteries, or emphysema. Of most consequence in this stage, however, are the contractions of the muscles of mastication and the posterior muscles of the tongue. By means of the stylo-glossi and the glosso-pharyngei the tongue is drawn spasmodically backward, pressing the epiglottis down so as to close mechanically the aperture of the larynx. Such patients become blue in the face and die suffocated—not through the direct action of the chloroform, but from the mechanical privation of air," unless the tongue be well drawn forward or the chin tilted upward.

Anæsthetics affect the brain of different people in as many ways as drunkenness. One will be quarrelsome, a second violent, a third sentimental, and others maudlin, melancholic, or merry.

In epileptic subjects I have seen patients pass through some epileptic convulsions during their progress toward narcosis.

The best rules for the administration of chloroform, ether, or any anæsthetic are those given by the chloroform committee of the Royal Medical and Chirurgical Society of London (1864). It was my privilege to act as one of the members of that body, and all my subsequent experience has convinced me of the value of the suggestions then laid down. I quote them in full, with only a few modifications.

Rules relating to the Administration of Anæsthetics.

Anæsthetics should on no account be given carelessly or by the inexperienced; and when complete insensibility is desired, the attention of the administrator should be exclusively confined to the duty he has undertaken.

Under no circumstances is it desirable for a person to give an anæsthetic to himself.

It is not advisable to give an anæsthetic after a long fast or soon after a meal, the best time for its administration being four or five hours after food has been taken.

If the patient is much depressed, there is no objection to his taking a small quantity of brandy, wine, or ammonia before commencing the inhalation.

Provision for the free admission of air during the patient's narcotism is absolutely necessary.

The recumbent position of the patient is preferable: the prone position is inconvenient to the administrator, but entails no extra danger. In the erect or sitting posture there is danger from syncope. Sudden elevation or turning of the body should be avoided.

An apparatus is not essential to safety if due care be taken in giving the anæsthetic. Free admixture of air with the anæsthetic is of the first importance, and, guaranteeing this, any apparatus may be employed. If lint or a handkerchief or a napkin is used, it should be folded as an open cone or held an inch or an inch and a half from the face.

Chloroform should invariably be given slowly. Sudden increase of the strength of the anæsthetic is most dangerous. Three and a half per cent. is the average amount, and four and a half per cent., with ninety-five and a half of atmospheric air, is the maximum of the anæsthetic which can be required, given cautiously at first, the quantity

within this limit being slowly increased according to the necessities of the case, the administrator being guided more by its effect on the patient than by the amount exhibited. Ether may be given more boldly.

The administrator should watch the respiration of his patient, and must keep one hand free for careful observation of the pulse.

When patients hold their breath, more air should be admitted; and when the movement of swallowing is seen, it should be accepted as evidence that the anæsthetic is stronger than necessary. On any sound of stertor fresh air should be admitted.

The patient who appears likely to vomit whilst beginning to inhale the anæsthetic must at once be brought fully under its influence; the tendency to sickness will then cease.

The occurrence during the administration of an anæsthetic of sudden pallor, lividity of the patient's countenance, or sudden failure or flickering of the pulse, or feeble or shallow respirations, indicates danger and necessitates immediate withdrawal of the anæsthetic until such symptoms have disappeared. The chin should be raised as much as possible from the sternum, and if this movement fail to open the larynx, the tongue should be pulled forward and the head drawn back.

Nélaton and Marion Sims advise the inversion of the body, with the view of throwing what blood there is wholly to the brain, on the theory that death from chloroform is, as a rule, due to syncope or to cerebral anæmia. In the more threatening cases commence instantly with artificial respiration, whether the respiration has failed alone or the pulse and the respiration together. Galvanism may be used in addition to artificial respiration, but artificial respiration is on no account to be delayed or suspended in order that galvanism may be tried.

In extreme cases laryngotomy may be required.

Few, if any, are insusceptible to the influence of anæsthetics, from two to ten minutes being required to induce anæsthesia. The time varies according to age, temperament, and habits.

The mixture of alcohol one part, chloroform two parts, and ether three parts, which should be mixed fresh before use, should be given in the same way as chloroform alone, care being taken, when lint or a handkerchief is used, to prevent the too free escape of the vapor.

In Vienna the favorite mixture is three parts of ether to one of chloroform. Billroth employs chloroform three parts, ether one part, and alcohol one part.

Use of Anæsthetics in Surgical Operations.

Any person fit for a severe operation is a fit subject for an anæsthetic, but no one is so free from danger that care in watching its effects can be dispensed with. The cases requiring the greatest vigilance are not the young and delicate, for whom a small dose suffices, but the strong, who inhale deeply and struggle much. Ether is probably better for those suspected of fatty degeneration of the heart, although, as a rule, such cases are eminently satisfactory under chloroform.

In phthisis, when an operation is unavoidable, anæsthetics may be given with impunity.

For all operations upon the jaws and teeth, the lips, cheeks, and tongue, anæsthetics may be inhaled with ordinary safety. By care and good management the patient may be kept under their influence to the completion of the operation. In these cases blood, as it escapes, if not voided by the mouth, passes into the pharynx. If any small quantity finds its way through the larynx, it is readily expelled by coughing. In operations upon the soft palate, fauces, pharynx, and posterior nares, if sudden or severe hemorrhage is likely to occur, it is not advisable to induce deep insensibility. In cases requiring laryngotomy and tracheotomy anæsthetics may be employed with safety and advantage.

For operations upon the eye involving the contents of the globe the use of anæsthetics is open to objection, on account of the damage which the eye may sustain from muscular straining or vomiting. If employed, profound insensibility should be induced. Recent experience tends rather to prove that anæsthetics may be used without fear in most eye operations.

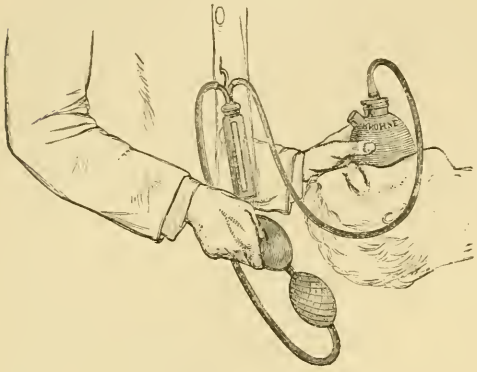
In operations for hernia and in the application of the taxis anæsthetics act most beneficially. For most operations about the anus and perinæum profound anæsthesia is positively demanded.

In the condition of shock or of great depression, as after hemorrhage, the careful administration of anæsthetics diminishes the risk of an operation.

In all cases other than those specially referred to it is sufficient to state, so far as a mere surgical operation is concerned, that anæsthetics may invariably be administered.

The continuous vomiting occasionally induced by and following upon the inhalation of anæsthetics may be injurious by consequent exhaustion as well as by mechanically disturbing the repair of a wound. With this reservation, they do not appear to interfere with the recovery of patients from surgical operations.

Fig. 686.



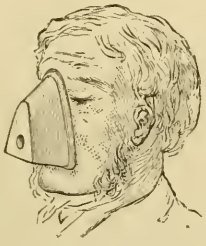
Junker's Chloroform Inhaler.

The results of 2586 capital operations performed before, and of 1847 performed since, the introduction of anæsthetics, which I collected from all authentic available sources, show that the rate of mortality has not been increased, even though much graver operations have been done under the influence of anæsthetics. The risk attending the inhalation of chloroform is very small, being about 1 in 3000 administrations. This is enough to forbid its use in trivial cases, but not enough to do so in cases of capital operation or where it is required for purposes of diagnosis. In children it is very safe.

The best instrument for the administration of chloroform I believe to be that of Junker (Fig. 686). In it a drop of chloroform vapor is vaporized by each full compression of the air-ball and a stronger vapor cannot be given. It may be employed without the mouth-piece. If the ball is compressed before each inspiration, no vapor will be lost. I use nothing but this in my own practice. The older instrument which I introduced at Guy's in 1864 (Fig. 687) is, however, portable and good. It is not complicated by any valves, but is merely a mouth and nose-piece lined with lint, with openings to admit air freely. Within the last few years Skinner's inhaler, composed of a framework of wire covered with a layer of flannel, fastened to the frame by a gusset and tape, and a handle, has found much favor and is very useful.

Clover's apparatus is, however, very good when it can be obtained. It is composed of an india-rubber bag into which chloroform or any other anæsthetic is pumped, mixed with atmospheric air. Clover employs three or four per cent. of chloroform. It is, however, a cumbersome apparatus and cannot be at universal command. When he gives nitrous

Fig. 687.



Chloroform Inhaler.

Fig. 688.

Inhaler with Bottles and Strap Complete.

Perforated Inhaler as Applied. (Rendle's inhaler, as improved by Morris.)

oxide gas at first and follows it up by ether, his apparatus is equally satisfactory. For ether or the anæsthetic A. C. E. mixture the leather bottle-shaped apparatus, as suggested by Dr. Golding Bird, or the one figured above as made for Mr. Rendle and improved by Morris (Fig. 688), is very valuable.

The **bichloride of methylene** is recommended to our notice as an anæsthetic of great power. Patients are said to be brought under the influence of the drug in twenty or thirty seconds, and to recover from it rapidly with little inconvenience. No sickness or headache is said to follow its use, unless the inhalation has been continued for many minutes or a second dose is given to keep up the effect. Of course, if the inhalation be prolonged, the after-effects resemble, though in a less degree, those of chloroform, save the one—absence of muscular excitement.

Dr. Bouchut (*Gazette des Hôpitaux*) recommends the use of chloral as an anæsthetic for children. He gives one dose, not exceeding forty-five grains, in children under three years of age. In half an hour the patient is asleep, and in an hour insensible. The anæsthesia lasts from three to six hours and is followed by no unpleasant consequences. Thirty grains may be given without danger, Bouchut says, to children between two and five years of age (*Brit. Med. Journ.*, November 16, 1878).

In abdominal surgery, such as ovariotomy, Keith has said that ether is less prone to be followed by sickness than chloroform; and if the success of an operation is any argument in its favor, Keith's must be quoted. I have for some years employed the mixture recommended by the chloroform committee—of alcohol, chloroform, and ether—and think well of it. I believe it to be as good as chloroform, and less likely than any other to be followed by that bane of all anæsthetics, vomiting.

In the operations of dentistry and all short measures the nitrous oxide gas is of great value.

After the use of any anæsthetic everything should be given cold for twelve or twenty-four hours, to prevent sickness; ice, indeed, may be sucked with advantage, and ice and milk form a very favorite mixture. If hot food be given, vomiting is far more likely to appear or to be aggravated.

Secondary Uses of Anæsthetics.

Anæsthetics, however, have other uses than the destruction of pain. As aids to diagnosis they are of priceless value, both to the physician and to the surgeon. To the surgeon they have also opened up new fields for his scientific art which were formerly but little known. I shall point them out, however, but briefly, quoting from a lecture I had the honor of delivering at the Hunterian Society in 1870:

"Chloroform as an aid to diagnosis stands second to no means which we have at our disposal. To the physician who has a difficult case of abdominal tumor, what facilities it gives him for its thorough investigation! Suspected tumors become phantoms; so-called movable kidneys slide away and indefinite conditions become clear and intelligible. With how much greater certainty a physician can think over a doubtful case, decide upon its nature, deliver his opinion, and treat it, when he has adopted this means of investigation! In hysterical subjects it renders a thorough abdominal examination a possibility when no such otherwise existed, and in what class of cases, may I ask, is it more necessary to make a positive diagnosis than in this? In my own practice it enabled me on one occasion to make out a pregnancy when an ovarian tumor had been diagnosed by men whose authority was undoubted, and in a patient whose position in life rendered the suspicion of pregnancy almost a libel. Indeed, the ovarian nature of the disease was looked upon as so decided that my aid was sought solely for the operation. In this case an examination of the abdomen was impossible, from hysterical sensibility; but under chloroform all difficulties disappeared. To the physician-accoucheur may I not also assert it to be equally valuable for diagnostic purposes? To answer this fully is out of my province, but I have known a case of cystic disease of the uterus which was about to be operated upon as an ovarian tumor made out by the use of the uterine sound, with the patient under chloroform, when an examination by the same instrument made before had failed to yield any such evidence. In the surgical diseases of children is it possible to overestimate its value? With what gentleness can difficult examinations be now made of injured limbs! and with what certainty can we now apply our treatment! In sounding for stone what facilities it affords! In general surgery what new fields has it not opened? Would nephrotomy or nephrectomy have been entertained? Where would ovariotomy have now been, may I ask, had not chloroform been in use? Would it have been an established operation in surgery? Could it have been so successful? The answers to these questions, I think, are plain: they must be in the negative. It is true the operation had been performed before its introduction; it had been successful in a few cases, but it had almost fallen out of practice; its revival was due, without doubt, to chloroform, and its present established position to the general use of that drug. No operation requires more gentleness and nicety, and how could these essential points of practice be applied with a patient writhing under the agonies of an abdominal section? To all abdominal surgery the same observations are applicable, although they may not tell, perhaps, with the same force. Without anæsthetics could Bigelow have perfected his rapid lithotrity? and would Thompson have practised so boldly his operation of cystotomy for the removal of bladder tumors?

"Let us now refer to another class of cases—to that large one known as belonging to plastic surgery. How many cases of vesico- or recto-vaginal fistula were successfully treated by operation before chloroform was introduced? At Guy's Hospital I can find no record of such. The physician-accoucheur used to cauterize the margins of the fistula, it is true, but, I fear, with poor success; for I have never heard of a case of any size being so cured. At the present day these cases are now to be cured by operation with as much certainty as any other class. They have, in truth, been removed from the incurable to curable affections. And yet these instances of plastic surgery are only a portion of those which I might enumerate.

"In the treatment of deformities about the mouth, nose, and eye, in the division of cicatrices after burns, in the treatment of ruptured perinæum with all its complications, what innumerable cases might be quoted now, against the few of former times!

"Again, in the operations on bones and joints, how many of the improvements in our practice are there that may not be put down to the use of chloroform—operations for necrosis in particular? How rare these were, and how unsatisfactory they must have been, before its introduction! I can recall a few which I saw in my student's days with no pleasant feeling. How common they are now, and how successful! Taking Guy's as a type of the metropolitan hospitals, an operation for necrosis can always be found for operating days, the operation is so frequent and so satisfactory. In the removal of bone from joints, in the excision of joints, it is only fair to believe that a great part of the success which now attends the practice is to be attributed to the use of an anæsthetic. How many hands and feet which would formerly have been sacrificed are now saved by the removal of diseased bone it is difficult to estimate. Would Sir W. Fergusson have framed the phrase 'conservative surgery,' and could it have been adopted, before the introduction of chloroform?

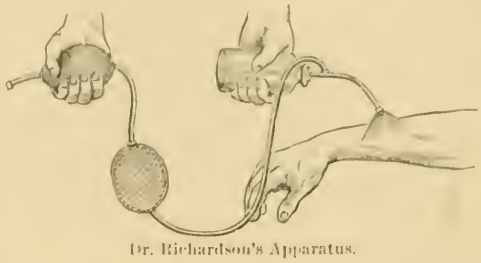
"In the treatment of aneurisms have not like improvements to be recorded? Has not chloroform rendered possible the cure of aneurism by pressure? Has it not also rendered the practice of torsion of arteries for the arrest of hemorrhage a practical success, thus simplifying surgery? How many cases of strangulated hernia are now reduced which in former times would have been submitted to strange treatment and to a delayed operation! How simple it has comparatively rendered the reduction of recent dislocations! Where are now the pulleys, the ropes, and the other frightful mechanical appliances that were used of old for the reduction of dislocations of the hip-, shoulder-, and other joints? Are they not decaying in the lumber-rooms of our hospitals? and has not the use of chloroform made the reduction of dislocations by manipulation a reality? On one occasion I reduced with ease, by manipulation, a dislocation of the elbow-joint backward, complicated with fracture of the humerus, which would probably have been left unreduced before the introduction of the anæsthetic, and more recently the head of the humerus dislocated on to the dorsum of the scapula, complicated with fracture through the tuberosities.

"Let us contrast for one moment the operation of perineal section for stricture as it was and is now performed. Do we not all remember it as one of the most unsatisfactory and unsuccessful of surgical operations? Do not we know it to be one of the most satisfactory and successful? Indeed, I might continue the contrast between the pre-anæsthetic period and the present, but I think I have said enough to show that to the introduction of chloroform many of our best improvements in surgical practice are to be attributed. For the surgeon it does away with all excuse, if any ever existed, for hurry in an operation. He can take his steps in it with deliberation and make it a certainty. We never see now, happily, a theatre full of spectators observing the operation watch in hand, and I trust there are few, if any, surgeons who at the present day sacrifice safety and certainty in their operations for expedition and display. The use of anæsthetics has rendered the practice of surgery safer, surer, and more scientific. It has removed difficulties from the practice of our art which before were insurmountable, and has rendered possible innumerable things that could not in former times have been entertained."

Local anæsthesia may be brought about by freezing a part, as suggested by Dr. J. Arnott, or by means of the rapid evaporization of pure anhydrous ether, as practised by Dr. B. W. Richardson. Both are valuable means of diminishing pain where anæsthesia by inhalation is forbidden or inapplicable. Arnott's plan is carried out by mixing up finely-pounded ice in a gauze net or thin translucent india-rubber bag with half its bulk of powdered salt, the net being placed over the part to be benumbed. If well applied, it renders the skin at once pale and bloodless; and if continued, of a tallowy, death-like aspect. When too long applied, it may produce frost-bite or chilblain.

Dr. Richardson's ether spray is a more elegant, as it is a more effectual, mode of applying local anæsthesia than ice. It is worked by his well-known apparatus, consisting of a tube with india-rubber ball and second spring ball to make the current continuous, the air being pumped in through this tube into a bottle containing anhydrous ether of a sp. gr. 0.723 and of a boiling-point of 96° Fahr. Through the stoppered neck of this bottle a glass tube is passed, which reaches at one end nearly to the bottom of the bottle and at the other is fitted with a point with one or more perforations, through which the ether is forced in a fine spray, this spray being directed upon the part to be benumbed (Fig. 689).

Fig. 689.



Dr. Richardson's Apparatus.

For opening abscesses, taking out small tumors, the removal of external piles, and other minor operations, this local anæsthesia is of great value, but in graver surgical acts it is inapplicable, as it affects only the surface and is but skin-deep in its influence.

CHAPTER XXXVI.

AMPUTATION.

General Remarks.

When a limb is saved by the excision of a joint, and life prolonged by the application of a ligature to or the torsion of a wounded or diseased artery, surgical science claims a triumph; and surely an equal triumph ought to be accorded to her when, by the removal of a part that interferes with its duties, life is rendered more valuable, or by the amputation of a limb that is irreparably injured or diseased death is averted. To say that amputation is an opprobrium of our art is to take a narrow view of its objects, since, as the first object of the surgeon is *to save life*, the necessary sacrifice of a limb becomes the truest *conservatism*. To sacrifice a limb unnecessarily is an error which the surgical mind would never willingly commit, although to sacrifice life in the feeble effort to save a limb is one of far greater magnitude. It is an error, however, that timid surgeons are too likely to fall into when inoculated with the narrow views of a spurious conservatism, since to leave a limb alone with the hope of saving it is a passive act of the professional mind that requires no effort, while to make up the mind to act requires courage backed up with knowledge and a full sense of responsibility. The operation of amputation itself requires nicety and well-applied mechanical skill, but to determine upon its necessity or otherwise requires a high order of knowledge, a careful balancing of probabilities, and much decision.

It is not my intention to discuss in the present chapter the conditions under which amputation may be called for, since these have been fully considered in the different chapters devoted to such injuries and diseases as may require this treatment. I propose simply to consider amputation as an operation, to point out the best modes of its performance under the different conditions in which it may be demanded, and to describe the various forms of operation as applicable to different parts.

To supply the history of amputation would be an interesting but a too extended process. In *Cooper's Surgical Dictionary* and *Holmes's System* two able articles will be found upon the subject which contain all that can be desired. For the present purpose it will be enough to state that the first amputations were performed by the *circular method*, the soft parts being divided down to the bone by a circular sweep of the knife (*vide* Celsus), the hemorrhage being arrested by the red-hot iron and the bone divided by a saw.

About 1718, J. L. Petit, the French surgeon who improved the tourniquet now known by his name, as well as our own great surgeon, Cheselden, suggested that the skin and fat

of the limb to be removed should be first cut through and retracted and then the muscles and bones divided as high as they were exposed. Still later, Louis of Paris adopted the practice of dividing by the first cut the skin and superficial layer of muscles, by the second the deeper muscles down to the bone at the line of the retracted superficial layer, and lastly the bone itself. He also used a retractor.

In 1779, Alanson of Liverpool made a still further advance by cutting the integument as usual and allowing it to retract and then dividing the muscles obliquely upward, cutting from without down to the bone, more after the modern flap operation, the bone being subsequently divided. The soft parts in this operation on being brought down formed a conical cavity with the bone at the apex, Alanson's object having been to prevent the sugar-loaf stump. Still later, Benjamin Bell of Edinburgh and Hey of Leeds secured the same end by first dividing the integument with a circular cut and dissecting it up, then the muscles at a higher level, and lastly the bone, this being divided at a point considerably above the line of the retracted muscles. Hey, moreover, in the thigh amputations suggested the expediency of dividing the posterior muscles longer than the anterior, to compensate for their greater retraction.

The **flap operation** is more modern than the circular, and to Mr. James Young of Plymouth is due the credit of having first published, in 1678, the method which he informs us he had "from a very ingenious brother of ours," Mr. C. Lowdham of Exeter. He made one flap only of skin, divided the muscles by the circular plan, and stitched the parts together. Eighteen years later Verduin of Amsterdam made the first muscular and skin flap by perforating the limb and cutting outward (transfixion).

To Liston must be attributed the credit of having fully established the flap operation, and in the pre-anæsthetic period, when time was a point of consideration, the expedition with which amputation could be performed by transfixion, compared with the tediousness of the circular operation, tended much toward this end. It was thought, moreover, that a large mass of muscle formed a good covering to the bone and yielded a better stump than that in the circular. Experience soon proved, however, that this opinion was not supported by facts—that the supposed advantages were not real and did not compensate for the larger extent of wound caused by the flap operation and for the evil of often having to tuck in the projecting ends of the divided muscles before the integuments could be adjusted. Liston saw this before he died, and was led with Syme to modify his operation, making in muscular subjects two lateral crescentic skin flaps with their convexity downward and dividing the muscles as in the circular method. This operation is by far the best for all amputations of the leg and fore-arm.

In more modern times Lowdham and Young's practice has found expression in Carden's operation, while Teale's amputation must be regarded as a modification of the flap. Both these gentlemen, however, advocated the long anterior flap in preference to all others, Teale making two rectangular flaps of unequal length of skin and muscle (Fig. 695), and Carden a rounded anterior flap of skin alone (Fig. 696); and under certain conditions nothing can be better than the results obtained, the line of cicatrix being posterior to the extremity of the stump and out of harm's way, thereby allowing the patient to rest part, if not all, of his weight upon the stump.

The chief objections to the operation consist in the tendency there is for a long skin flap to slough and the necessity of dividing the bone at a higher level than would be required in the circular operation, when a long flap cannot otherwise be made. In muscular subjects this last objection is serious and fatal to the operation in many thigh amputations, for it is a truth that cannot be too forcibly recognized that in the thigh the danger to life is increased with every inch of bone removed. The surgeon who invariably practises Teale's amputation will often sacrifice a large portion of a limb that might otherwise be saved and have to amputate at a higher point than the necessities of the case demand, thereby often adding to the danger of the case as well as performing a needless and unjustifiable operation. The surgeon who removes such portions of the body as require removal, and no more, by such a flap as allows the cicatrix to be placed behind the stump and out of harm's way, performs a good and scientific operation.

Under all circumstances any form of amputation must be looked upon with favor that takes away *only* what needs removal and provides sufficient integument to cover the end of the stump, that ensures the cicatrix being out of harm's way, and that no nerves are likely to be involved in the cicatrix or fixed to the end of the amputated bone. Any form of amputation must be regarded with disfavor that requires the removal of more of the body than is essential to carry out the surgeon's primary aim and increases the risk of the operation, however good may be the stump secured. To provide sufficient

integument to cover the stump is a wise and necessary measure, and to fail in this when circumstances do not compel must be regarded as bad surgery; yet in certain cases of injury, disease, or gangrene of the extremities, where it is advisable to take away the diseased or injured parts and no sound skin is left from which to make a flap, amputation should be performed without regard to a covering for the stump, as doubtless it is better to remove the diseased part that is hastening on the end and leave the stump to granulate than to allow the disease to have its way and sacrifice life. At the hip- and shoulder-joints, where this contingency is most likely to occur, the adoption of this practice is not rarely called for, and at other parts is equally applicable, for, knowing what good stumps are often obtained when the skin and soft parts that at the time of the operation covered in the bone subsequently sloughed, I am convinced that in certain injuries to the arm and leg the surgeon had better amputate with a poor flap at the elbow- or knee-joints, leaving the rest to nature, than risk life by amputating higher up—*i. e.*, through the shafts of the humerus or femur. I have on many occasions acted on this principle, and to prevent the necessity of amputating above a joint in order to make a good stump with a skin covering amputated at a joint or below, utilizing even injured skin or bruised tissues, and rarely have been disappointed in the result, the stump subsequently granulating well even when the flaps themselves sloughed. In injuries to the leg this point is of great importance, since the mortality of amputation of the thigh for injuries is very great. As an admirable illustration of the value of this practice a case may be referred to (Circ. No. 3, Depart. of War, Washington, page 216) in which recovery ensued after all four limbs of a man æt. 26 were amputated on account of frost-bite. A month after the injury, when the line of demarcation had exposed the bones, Dr. Muller, in order to save loss of blood, which would have been serious in the patient's weak condition, dissected as much healthy flesh from the radius and ulna as the line of demarcation would admit without cutting any blood vessels, and then sawed through the bone. This operation was performed on both arms with hardly the loss of any blood. On the third day both legs were amputated in the same manner. In this case not one of the four stumps could be covered with sufficient skin, and much had to be left to self-reparation, which took place to an extraordinary extent, the stumps healing over with healthy granulations, some little exfoliation of bone taking place in two.

Again, is it always necessary to amputate through healthy tissues? or, to gain this end, is it expedient to amputate higher up than would otherwise be necessary? I unhesitatingly answer that such practice is not called for. To amputate through tissues infiltrated with cancer or other new growths would, of course, be futile and bad surgery, but to cut through tissues that are merely infiltrated with inflammatory products, that are pathologically reparable and of use, is a wise and conservative process. In disease of the knee-joint, when suppuration has spread up the thigh into the soft parts, amputation may often be performed through the condyles or just above them and a good stump secured when by following another practice a much higher amputation would be called for, and consequently increased risk to life incurred. Tissues infiltrated with inflammatory lymph often unite rapidly and well; indeed, I have seen "brawny flaps" unite by primary union quite as well as others not so infiltrated.

I am convinced, too, that however desirable it may be to obtain good, long, and healthy flaps in all amputations, the advantages of such are not so great as to justify the surgeon in sacrificing more of the body than is essential, thereby adding to the risks of the case, and more particularly in amputating above a joint. It is true that by one form of amputation a better stump under most favorable circumstances is often secured than another, but it is equally true that *good* stumps are often obtained under the most unfavorable conditions and that *bad* stumps follow the amputation of a limb in which the state of the flaps promised to bring about a favorable result. To assert that the form of amputation—or, rather, that the shape of the flaps, etc.—has anything to do with the relative mortality of different amputations is incorrect. What evidence exists points to a different conclusion, for the success of an amputation, as of any other operation, turns more upon what in recent times seem to have been forgotten—viz., the conditions of the *viscera*, the *age*, and the general state of the subject, accepting the facts that the older the patient, the greater the danger, and the more of the body that is removed, the greater the risk. My own conviction is that, however desirable it may be to obtain a model stump, the end is not sufficiently certain or important to justify the surgeon in adding one tittle to the risk of the operation or in sacrificing more of the limb than the necessities of the case demand. I regard it as bad and unjustifiable surgery to perform a Syme's or a Pirogoff's amputation when a Chopart's will suffice; to amputate a leg when the removal of a foot at the

joint will answer the purpose; to remove a leg or thigh an inch higher than is absolutely called for, in order to execute what may be looked upon as a good operation or to gratify a fancy; to amputate through the condyles of the femur when an amputation at the knee-joint can be performed, or through the shaft of the femur when the like end may be secured by cutting through the condyles. The surgeon must ever look upon the operation of amputation as an unfortunate necessity, and should bear in mind that it is to be undertaken only to save or to prolong life or to add to life's usefulness. With these ends in view, he should not add one jot to its dangers or take away an inch more of the body than is essential. The beauty of a stump may be something in itself, but is nothing if it is to be obtained by increased danger, and the brilliancy of an operation is a snare that should never be allowed to draw the surgeon away from the main object—the preservation of life—which alone gives the operation of amputation a high and scientific position in surgical practice.

The mortality of amputation is determined more by age than by anything else, and the credit of having statistically proved this fact is due to Mr. Holmes (*St. George's Hosp. Rep.*, 1866 and 1877). In my own paper on the causes of death in amputation (*Med.-Chir. Trans.*, vol. xlii., 1859) this point was overlooked, but, following Mr. Holmes's example, I reanalyzed the cases on which it was based, and have been somewhat startled at the very definite conclusions brought out by my analysis. Thus, out of 103 cases under twenty years of age, 10 died, or 1 in 10; out of 111 cases between twenty-one and forty years of age, 21 died, or 1 in 5; out of 74 cases over forty years of age, 22 died, or 1 in $3\frac{1}{2}$, the mortality of amputation between the ages of twenty and forty being exactly twice as great as before twenty years of age.

Mr. Callender (*Med.-Chir. Trans.*, vol. xlvii., 1864) and Mr. Holmes's combined statistics reveal the same results:

	Cases under twenty years of age.	Between twenty and forty years of age.	Over forty years of age.
Callender's	61 cases, 3 died.	92 cases, 20 died.	74 cases, 30 died.
Holmes's	130 " 22 "	215 " 68 "	155 " 68 "
	191 cases, 25 died, or 1 in $7\frac{1}{2}$.	307 cases, 88 died, or 1 in $3\frac{1}{2}$.	229 cases, 98 died, or 1 in $2\frac{1}{3}$.

Fifty-two deaths having occurred in 250 cases reported by Mr. Holmes in subjects under thirty years, and 106 deaths in 250 cases operated upon after thirty years of age.

If the causes of amputation are looked at in the same light, the results become still more marked; for, dividing them into amputations for disease, for accident, and for expediency, the latter term including amputations for tumors, deformity, etc., the following facts are elicited:

	Diseases.		Expediency.		Accident.	
	Cases.	Died.	Cases.	Died.	Cases.	Died.
Under twenty years of age	68	4, or 1 in 17.	9	3, or 1 in 3.	26	3, or 1 in 9.
Between twenty and forty	66	12, or 1 in $5\frac{1}{2}$.	15	4, or 1 in 4.	30	5, or 1 in 6.
Over forty	33	5, or 1 in $6\frac{1}{2}$	9	3, or 1 in 3.	32	14, or 1 in $2\frac{1}{2}$.

Amputations for *acute* suppurative disease are most fatal and should be undertaken only when a strong necessity exists. I pointed this out in 1859, but it is not a fact sufficiently recognized.

Amputation in young life for chronic disease is most successful, being three times more so than at a later period, 1 only in every 17 dying; amputation for accident increases in fatality with age, and amputations of expediency are as dangerous at all periods of life as traumatic amputations are in the aged.

Mr. Callender has also well shown (*St. Barth. Hosp. Rep.*, 1869) that the mortality of amputations is much alike, whether performed in country hospitals, in country private practice, or in country cases in London. In amputations on London subjects, as in the subjects of all large towns, the mortality is somewhat higher.

Dr. Steele has, however, gone farther and proved by figures that amputations performed in London for injury on country patients are, as a rule, more favorable than when performed in town cases, the difference between the two classes being far less marked in amputation for disease than in that for injury (*Guy's Hosp. Rep.*, 1869–70).

The causes of death after amputation are as follows, taking these conclusions from my paper on the subject (*Med.-Chir. Trans.*, 1859), to which the reader must be referred for further details: *Shock and exhaustion* claim one-third of the fatal cases, and one-twelfth of all amputations; *pyæmia* was the cause of death in forty-two per cent. of the

fatal cases, and in one-tenth of all amputations; *secondary hemorrhage* in seven per cent. of the fatal cases, or one and a half per cent. of the whole number. Some *complication*, cerebral, thoracic, or abdominal, causes death in about four per cent. of all cases. Pyæmia is nearly twice as fatal after amputations of expediency as after those for disease or primary amputations, but is less fatal after secondary amputations than any others. In amputation of the leg it is twice as destructive as in that of the thigh, the larger section of bone being the more dangerous. In primary amputation of the leg it is more fatal than when performed for disease.

How far the deaths from secondary hemorrhage will be diminished when the practice of torsion of arteries is more general remains to be proved, although from the experience we have had at Guy's Hospital the promise of a better result is very great. Up to the end of 1874 we have had 200 consecutive cases of amputations of the thigh, leg, arm, and fore-arm in which all the arteries had been twisted (110 of them having been of the femoral artery), and no case of secondary hemorrhage; indeed, our house-surgeons never expect to be called to cases of secondary hemorrhage now that torsion is the general practice of the hospital.

Double amputations are of grave import and are very fatal. They are mostly undertaken for "smashes" or bad compound fractures. Out of 18 cases collected by my dresser, Mr. W. Blight, from the Guy's records, I can, however, record 5 successful cases, or 27.7 per cent. of the whole number. One occurred in my own practice in a woman æt. 35 who had a Syme's amputation on one foot and a Hey's on the other. Two occurred in the practice of Mr. Durham, and both in men—one, æt. 18, amputation of both thighs, and the other, æt. 19, amputation in one thigh and fore-arm. Mr. Davies-Colley took off both legs of a boy æt. 8 with a good result, and Mr. Jacobson took off one leg in the thigh and one below the knee in a man æt. 30 with a like result. Thirteen cases died soon after the operation.

The operation of amputation may be called for on account of some incurable disease or incurable injury. When performed for the first cause, the operation has been described as a *pathological* amputation; when for the second, *traumatic*. Both classes are also subdivided, the pathological into amputations for suppurative disease of bones and joints—pure *pathological* amputation; and into those for talipes, tumors, deformities, etc.—amputations of expediency.

Traumatic amputations performed during the first twenty-four hours after the accident, before any inflammatory complications have set in, are called *primary;* the term *secondary* is applied to the same class of cases after suppuration has appeared, the word *intermediate* being employed to designate amputations performed twenty-four hours after the accident, but before suppuration has declared itself. This distinction, however, is not a satisfactory one.

Some statisticians have classed the secondary amputations with the pathological, but this practice is clearly wrong.

The Different Modes of Amputation

may be divided into three great classes—1st, the *circular;* 2d, the *flap* operation, whether by transfixion or cutting from without inward—Teale's amputation (consisting of one long anterior skin and muscular flap, and short posterior) being looked upon as a modification of the ordinary flap operation; 3d, the *mixed form* of amputation—skin flap and circular cut through muscles—Carden's operation being included in this series. Into one or other of these classes almost every form of amputation may be brought, although practically there are innumerable modifications of each, more particularly of the flap.

The old **circular operation**, as already described, is now fairly abandoned. It has no advantages over the more modern mixed form of amputation, and will not take the place of the flap where the latter is applicable. In small limbs, where there is but little muscular tissue and a single bone to divide, it may be performed, but cannot be recommended. It is more practised abroad than in this country.

The **flap operation** doubtless owes its popularity as much to Liston, Lisfranc, and Velpeau, who were its strong supporters, as to the facility with which it is performed and the satisfactory appearance of the flaps at the time of the operation. Before anæsthetics were introduced expedition was of importance, and it was the surgeon's aim to remove a limb as rapidly as possible. "The surgeon, operating by the watch, took off a limb by the flap operation in as many seconds as there were minutes occupied in the old circular method" (Sir W. Fergusson). Since 1846, however, when anæsthesia came into vogue,

this necessity has ceased to exist, and surgeons have been led away more from the flap operation to what may now be described as the mixed.

In certain parts, however, the flap operation still holds its ground, and in a general sense it may be said that in operations where *the shafts of single* bones or some joints are involved it is the best method, while in some localities, as at the shoulder- and hip-joints, it is the only one open to the surgeon.

The objections to the flap operation are the large surface that is exposed, the danger of puncturing or slitting the main artery of the part, the inconvenience of bleeding, the leaving of the main artery and nerves in one of the flaps, and the disadvantage of a thick muscular flap.

The flap amputation has, however, one great advantage, and that is its capability of innumerable modifications. Thus, both flaps may be made by transfixing—the old plan; both may be made by cutting from without inward: one flap, the anterior, may be made by the latter method, and the second, or posterior, by transfixion; or lateral flaps, single, or double, or oval flaps, may be made.

The *advantages* of transfixing the flap consist in the rapidity and cleanliness with which the section of the muscles and the deeper parts is made; its *disadvantages*, in the irregularity with which the skin is too often divided from the elastic integuments stretching before the knife. By the plan of cutting the flap from without inward this disadvantage is, however, neutralized, while an extra advantage is gained, for the surgeon can often cut a longer skin than muscular flap, which in large limbs is a matter of importance.

In some amputations, as of single bones, the operation may be performed by cutting the anterior flap from without inward, and the posterior by transfixing. In the arm and thigh, when I select the flap amputation, this method is that which I usually adopt. In cutting the flap by transfixion, particularly in the thigh, the surgeon should always support it with his left hand, and when a sufficient flap has been made cut sharply outward (Fig. 691).

Sir W. Fergusson says, with respect to the flap operation, "If, in transfixing, the flaps be made purposely short, and then, retraction being made, the knife be carried round the exposed tissues which cover the bone, a cone will be formed resembling that in the ordinary circular operation, and thus by a combination, a compromise, of the two methods (the circular and the flap), a covering to the end of the bone—in other words, a stump—will be left, superior, in my estimation, to any other," though he adds that "cutting from without inward is in many instances followed by the best results" (*Lect. on Prog. of Surg.*, 1867).

Besides these recognized forms of amputation, many others are performed, the surgeon having too often "to cut the flap according to the tissues," particularly in cases of injury. He has to utilize what skin there is left uninjured, in order to prevent the necessity of amputating higher up; it may be that one external or internal flap can be made, one anterior or posterior; in fact, any form or combination of flaps the surgeon may be called upon to make to carry out the object he has in hand—viz., the removal of the part that must be removed, and no more, with the least sacrifice of parts. Indeed, as already stated, under rare circumstances an amputation may best be performed without flaps or with poor ones, it being a safer, and I believe a sounder, practice to take off a part that *must be* removed to save life immediately above the seat of injury, even with bad, poor, or no flaps, than for the sake of making flaps that may slough to amputate higher up, possibly with the sacrifice of a joint, and by so doing to incur an unnecessary danger to the life we are operating to save, Petit's fundamental rule being far from true—that "as little of the flesh should be cut away as possible: but the more bone is removed, the better" (*Traité des Malad. Chir.*, tom. iii. p. 250).

As a variety of the antero-posterior flaps the surgeon may at times, by transfixion, make the posterior one first, and then, taking between his fingers and thumb all the soft parts not included in the posterior flap, complete the operation either by passing the end of the knife beneath these tissues and cutting outward or by cutting from without inward, as in the former case. This plan is most expeditious and was the one generally adopted by the late Mr. Morgan of Guy's.

In some cases two lateral flaps may be made by either transfixion or cutting from without inward.

THE FLAP OPERATION.—The surgeon, having decided upon the operation and obtained the consent of the patient or of his friends to its performance, should see, unless time presses, that any fecal accumulation is removed by either a mild aperient or

an enema administered thirty-six hours beforehand, and that as good a meal as the patient can take be given four or five hours before the time fixed for the operation. The meal should be of meat where possible, with some stimulant, or, when solids are not acceptable, of a mixture of milk, egg, and brandy; for, assuming that chloroform or some anæsthetic is to be administered, it is essential to guard against sickness and to have the process of digestion fairly completed beforehand, since vomiting is more prone to take place with a full than with an empty stomach. The part to be operated upon should be well washed previously and when much hair is present also shaved before the patient is placed upon the operating table.

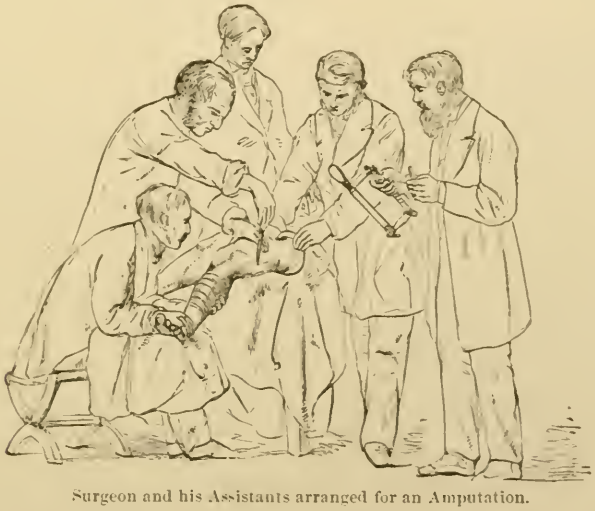
All instruments and dressing appliances should be arranged out of the patient's sight before the time of the operation, and a sufficient number of assistants provided and special duties allotted to them.

Thus, on one tray there should be a tourniquet or elastic bandage, to prevent hemorrhage; good torsion forceps to twist, or ligatures to tie, the vessels; amputating knives of sufficient length and size, with a bistoury or catlin to divide the soft parts, and saw and bone forceps for the treatment of the bone: a tenaculum should likewise be at hand, to take up vessels that have retracted; there should be also a pair of scissors and a linen retractor. The torsion forceps I employ (Fig. 137) are as good for taking up an artery to tie as for twisting.

On a second tray every appliance for the dressing of a stump should be arranged, such as suture needles armed with waxed silk, wire, or carbolized catgut; strapping cut into sufficient lengths and breadths; lint for pads or dressings, and splints when applicable; a can for hot water, to heat the strapping, should not be omitted; hot and cold water in abundance, *clean* sponges, supplied by the surgeon, well washed in iodine water and squeezed dry, and soft towels, so arranged as to be always at the surgeon's command during the operation, must be provided.

With respect to assistants, one to give the anæsthetic is a necessity; and when possible he should be an expert to whom the surgeon can resign his patient with confidence, as it is trying and somewhat risky for the operator, when otherwise engaged, to have an eye to the anæsthetist. A second is wanted, to hold the limb above and to command

FIG. 690.



Surgeon and his Assistants arranged for an Amputation.

the artery of the limb to be amputated: a third, to hold the limb below till it is removed, and subsequently to sponge and help to twist or tie the vessels: while a fourth is of essential service in amputation of the thigh and leg to hand the instruments, sponge, or to do what may be required, etc. They should be placed as shown in Fig. 690.

The nurse should be near, to take away and clean all sponges as they are used, and to replace them with others squeezed quite dry.

When the operation has to be performed by daylight, the table should be placed where the best light can be obtained; and when by candlelight, sufficient provision must be made. A good operating lamp is of great use, as well as a hand-glass to throw light upon any one part.

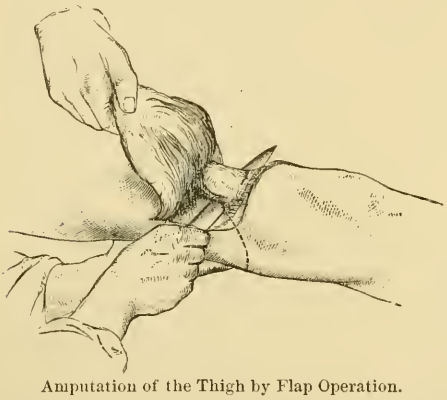
The operating table should be narrow and steady, a kitchen table with flaps being the best and always available. In hospitals there ought always to be a special table.

In amputations of the upper extremity the patient should be brought well to the side of the table, and in amputations of the lower extremity well downward, the opposite limb being secured by a turn of a bandage or strap to the leg of the table.

In amputating, the surgeon should always stand on the *right-hand side* of the part to be amputated, in order with his left hand to keep full control of the flaps during the operation, and possibly of the main arteries, and afterward of the stump. He should, moreover, see that the tourniquet is so fixed as to control the vessel when tightened, which should on no account be done until the operation is about to be commenced. Before fixing the tourniquet the limb to be amputated should be emptied of its venous blood by raising its end for one or two minutes and smoothing the veins from below upward by pressure with the hand. The limb should then be constricted high up by a tourniquet or Esmarch's elastic bandage.

In the flap operation, now being considered (and for the sake of illustration I will suppose it to be a thigh), the surgeon should mark out with his eye the point at which he proposes to divide the bone, and, with his thumb on one side of the limb and his fingers on the other, grasp it at a spot corresponding to the base of the anterior flap he is about to make, cutting from without inward, taking care that the *base* of this flap is at least an inch lower down than the point at which the bone is to be divided. The anterior flap, which should be cut first and consist of skin, ought to be as long as the soft parts below will allow and large enough to cover half the stump, or rather more than half the diameter of the limb; but when possible, it may be longer, since it is now generally admitted that the long anterior flap forms the best stump. The skin flap should be broad and cut square, with the angles rounded off, but not pointed. The muscles should then be divided down to the bone with a clean cut of the knife, made from heel to point and reflected with the skin flap. The anterior flap having thus been made, the point of the knife ought then to be passed through the wound beneath the bone and the limb so transfixed as to include all the tissues that remain undivided. The knife should then be made to run downward parallel to the bone, far enough to make a flap of the required length, and then turned backward, the outward cut being made sharply (Fig. 691).

Fig. 691.



Amputation of the Thigh by Flap Operation.

During this stage of the operation the surgeon should with his left hand support the under surface of the posterior flap. When the anterior flap has been made of only sufficient length to cover half the face of the stump, the posterior must be cut long, to allow the two to meet. When the anterior flap has been a long one—two-thirds of the length required to cover the stump—the posterior flap need be only half the length of the anterior. Long flaps always yield the most satisfactory results.

When the flaps have been made they should be carefully held away from the bone, which is to be bared upward for about an inch above their base, where it is to be divided and two periosteal flaps cut and pressed upward. The soft parts ought to be carefully held away from the bone, to escape injury, and for this purpose the linen retractor is of great value. The saw must then be applied, the bow saw (Fig. 690) being probably better than the flat. It should be used from heel to end with a firm, decided, free movement, too much pressure upon it being likely to cause splintering of the bone. During these steps of the operation the assistant who holds the limb must be careful neither to elevate nor to depress it, for he will cause, by the former act, the surgeon's saw to become locked, and by the latter splintering of the lower border of the bone. The best plan for the assistant to adopt is to apply extension to the limb in the axis of the bone to be divided, as if to draw the patient downward, though not with sufficient force to effect this result.

When any splintering of the bone has taken place, the rough margin ought to be carefully smoothed down with the cutting forceps, care being observed not to tear away the periosteum.

Dr. McGill of the United States army has suggested the propriety of making the

periosteal flaps, as described above, to cover in the end of the divided bone in amputation, and gives three cases in which this was done with excellent effect (Circ. No. 3). I have adopted the plan on many occasions with satisfactory results, the end of the divided femur being in some cases capped with a mass of new bone.

The bone being sawn through, the stump is to be raised and the main artery at once seized; the vessel should be drawn out of its sheath, firmly held with forceps (Fig. 137), and sharply twisted sufficiently often for the surgeon to feel that resistance has gone. The end ought not to be twisted off. The smaller arteries should be treated in the same way; it is possibly the best practice to twist off the ends of the small muscular and cutaneous branches.

When ligatures are preferred, they may be used, the carbolized catgut probably being the best.

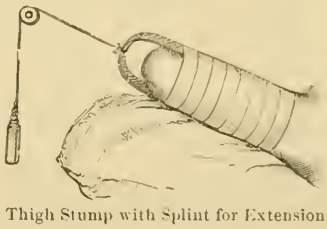
As soon as the chief vessels have been secured the tourniquet should be taken away and the stump elevated, to assist the venous circulation, the assistant being ready with his finger to compress the main artery of the limb if any vessel remain unsecured. Any nerve trunks that have been cut long in the flaps should be removed to a level with the bone. A stream of iodine water may then be made to pass over the end of the stump, to cleanse it of all blood and check capillary bleeding, and the surface should next be dried with a sponge squeezed dry out of hot iodine water, the surgeon satisfying himself that the vessels are all safely secured. The edges of the flaps may then be adjusted, and kept in apposition by sutures, which must not be put in too closely, but inserted about half an inch from the margin of the wound and made to perforate the skin and fat obliquely to the free border of the flap; the most dependent corner of the wound should be left open for the introduction of a drainage tube.

A posterior splint ought then to be fixed on the stump (Fig. 692), with pads of lint

Fig. 692.

Thigh Stump, with Splint.

Fig. 693.

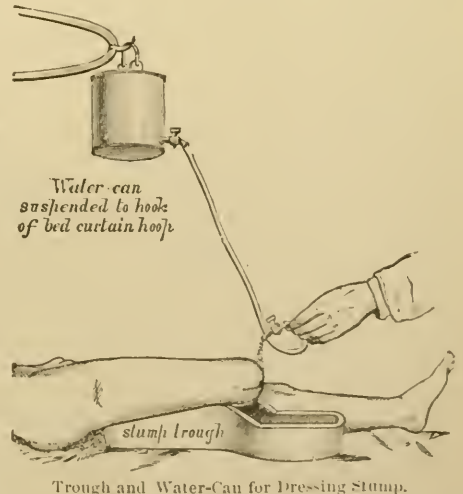


Thigh Stump with Splint for Extension.

or sponge, to maintain steady pressure upon the base of the flaps, though not on the wound, and a piece of iodoform or carbolic gauze, through which a hole has been cut for the end of the drainage tube, is to be applied to the surface of the wound.

A square of Gamgee tissue should then be bound over the stump, or a good large sponge, either of these materials forming a firm elastic compress which keeps the flaps well in apposition and checks bleeding, due care being taken to keep the end of the drainage tube exposed. To seal a wound completely and not to leave a drainage opening must always be regarded as bad practice. With well-adjusted flaps, good drainage, and rest, as secured by the application of a splint, most stumps may be expected to do well.

Fig. 694.



Trough and Water-Can for Dressing Stump.

The stump may be raised, as in Fig. 692, for the first day after the operation, but subsequently placed in a horizontal position. It should not be dressed for three or four days unless it becomes uncomfortable or there is any evidence of retained secretion, for the less the parts are disturbed during the early days, the better, repair going on much more satisfactorily when left alone than when the dressings are too frequently changed. To dress a stump, the trough, water-can, and tube, as illustrated in Fig. 694, are to be recommended.

When anything like retraction of the flaps exists, extension may be applied by means of a splint of perforated zinc, as seen in Fig. 693.

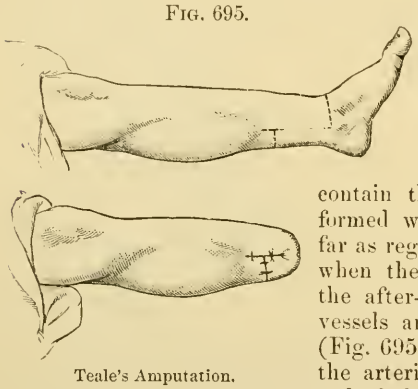
Before chloroform was introduced it was the practice of the late Mr. Aston Key, as well as that of Mr. Syme, to leave the stump open for a few hours before its flaps were brought together; and doubtless the measure was good, for in that time every bleeding vessel showed itself and the surface of the wound became glazed, and therefore in a state good for repair; but since anæsthetics have been in use this practice has fallen into desuetude. The application of the wet sponge, squeezed dry out of hot iodine lotion, renders, moreover, such a practice unnecessary.

The stitches may be taken away on the third or fourth day, when the parts, if they gape or if union is not solid, should be supported by strapping. The wound may be dressed with the mixture of terebene one part and olive oil three parts, or iodoform gauze and Gamgee tissue.

For the dressing of wounds the reader must refer to an early chapter.

Teale's Amputation, a Modification of the Skin and Muscular Flap.—This was introduced "to procure a more useful stump and in the hope of somewhat diminishing the mortality of the operation. It is proposed to amputate by a long and a short rectangular flap, the long flap folding over the end of the bone being formed of parts generally devoid of large blood vessels and nerves, whilst those important structures are contained in the short flap. The size of the long flap is determined by the circumference of the limb at the place of amputation, its length and its breadth being each equal to half the circumference. The long flap is therefore a perfect square, and is long enough to fall easily over the end of the bone. In selecting the structures for its formation such parts must be taken as do not contain the larger blood vessels and nerves. A flap so formed will be, for the most part, anterior in position, as far as regards the general aspect of the body, but superior when the patient is in the recumbent position, as during the after-treatment. The short flap, containing the chief vessels and nerves, is in length one-fourth of the other (Fig. 695). The flaps being formed, the bone sawn, and the arteries tied or twisted, the long flap is folded over the end of the bone and each of its free angles fixed by sutures to the corresponding free angle of the short flap. One or two more sutures may be required to complete the transverse line of union of the flaps and to unite the side of the short to the corresponding portion of the long, as well as the reflected portions of the long flap to its unreflected. Thus, the transverse line of union is bounded at each end by a short lateral line at right angles to it."

Fig. 695.



Teale's Amputation.

In making this long anterior flap the surgeon should be careful not to scarify it with his knife, more particularly when it is chiefly skin, as in the leg, since, on account of its length, it is very prone to slough, and if scarified this tendency is increased. Indeed, this sloughing of the long flap is the great disadvantage of the operation, for in an ordinary thigh, twelve inches in circumference, a flap of six inches would have to be made. To secure a cicatrix away from the extremity of a stump is a point of great practical value, and to do so by a long anterior flap is doubtless an advantage; but this often requires more soft parts than are generally at the surgeon's disposal, unless more of the limb be taken away than requires removal. This object may, however, sometimes be secured by making a shorter anterior flap than Teale suggests and dividing the bone one or two inches above the line of the skin flaps. In fact, as long as the anterior flap, whether rectangular or oval, is of sufficient length to be drawn over the end of the stump to its posterior aspect, the principle of Teale's operation is observed.

Mr. Spence in his *Surgery* (1871), p. 749, tells us that he acted much upon this principle in 1858, making one long *anterior skin and muscular flap*, with a short posterior, clearing the bone for nearly two inches before dividing it.

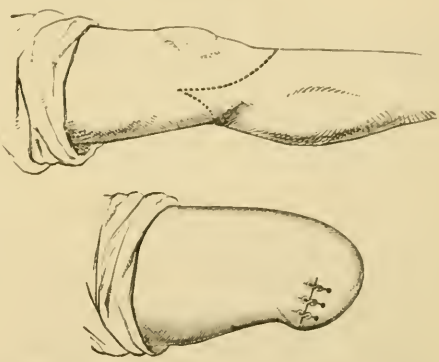
The Mixed Form of Amputation.—The mixed form of amputation as illustrated by Carden's operation will now claim attention. In principle it includes a combination of the circular and flap, already described.

"The operation consists in reflecting a rounded or semi-oval flap of skin and fat from the front of the joint (knee), dividing everything else straight down to the bone, and

sawing the bone slightly above the plane of the muscles, thus forming a flat-faced stump with a bonnet of integument to fall over it. The operation is simple. The operator, standing on the *right* side of the limb, seizes it between his left fore-finger and thumb at the spot selected for the base of the flap, and enters the point of the knife close to his finger, bringing it round through skin and fat below the patella to the spot pressed by his thumb; then, turning the edge downward at a right angle with the line of the limb, he passes it through to the spot where it first entered, cutting outward through everything behind the bone. The flap is then reflected and the remainder of the soft parts divided straight down to the bone; the muscles are then slightly cleared upward and the saw is applied. Or, the limb being held as before, the hand and knife may be brought round under the limb, as in the circular operation, and the blade entered near the thumb and drawn round to the opposite side, when the ham may be cut across by turning the edge of the knife upward, and the operation completed as before. In amputating through the condyles the patella is drawn down by flexing the knee to a right angle before dividing the soft parts in front of the bone; or, if that be inconvenient, the patella may be reflected downward" (*Brit. Med. Journal*, April, 1864).

This operation of Mr. Carden's is very valuable, not only as applicable to the knee-joint, to which it was originally applied, but on account of the principle of practice it embodies—that of making skin flaps and the circular division of the muscles. The practice, however, was not new; for when Mr. Carden began it, in 1846, Mr. Syme had published in the *Edin. Month. Journ. of Med. Science* of the same year his modification of the circular method of amputation in the lower third of the thigh by making two semilunar skin lateral flaps and oblique section of the muscles down to the bone, dissecting the skin flaps an inch or more upward, and cutting the muscles on a level with the retracted skin. Liston also, in 1839, preferred skin flaps alone in muscular subjects.

FIG. 696.

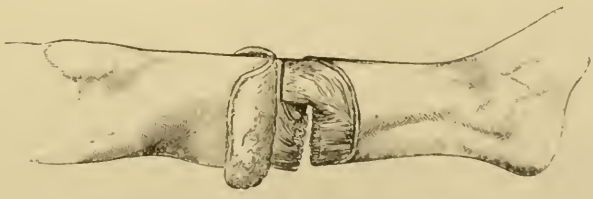


Carden's Amputation, with Long Posterior Flap.

Accepting it as an operation for the removal of a limb through the condyles of the femur, I have, however, found it advisable to make a slightly longer posterior flap than Carden advises (*vide* Fig. 696), making it only of skin, and taking care to make the long anterior flap broad, with a base corresponding to the posterior border of the lateral surfaces of the condyles.

In this operation there is but a slight section of the muscular tissue, and, beyond the popliteal artery, few vessels of importance are divided. The stump that remains is like-

FIG. 697.



Amputation of the Leg by the Mixed Method.

wise remarkably good, being long and broad, upon which patients can bear their weight without pain. This operation is, I believe, applicable to a far larger number of cases than is generally thought, and, with Lister, I look upon it as a great advance in surgery It is, moreover, far safer than amputation through the shaft of the femur.

The object sought in all these long anterior flap operations is to procure a cicatrix that is placed behind the stump out of harm's way, and so long as this end can be secured without sacrificing more of the body than is absolutely required by the exigences of the case the amputation is good, and it is a matter of small importance whether the rectangular and muscular flaps of Teale, the convex skin flaps of Carden, or the skin and muscle as practised by Spence, be employed. I prefer Carden's flap, with the modifications

described, to any other, and when applied to the knee, where it is most applicable, regard it with high favor.

This "mixed method of amputation" has, however, a wider application than to operations about the knee, and I believe it to be by far the best operation in all amputations of the leg and fore-arm. It combines the advantages of the circular and the flap without the disadvantages, and rarely, if ever, calls for the sacrifice of more of the extremity than is absolutely required. In its performance the two lateral skin flaps should be made sufficiently long to meet over the stump without stretching, the surgeon by his eye judging their required length, while the muscles should be divided by a circular sweep an inch below the base of the retracted flaps, the bones being bared to this extent before they are divided (Fig. 697). Mr. Cock includes the muscles in the flap, but I hardly think this necessary unless the skin is very thin. When the flaps are brought together, a pretty stump is seen, and subsequently it turns out to be a very good one (Fig. 698).

Fig. 698.

Stump after an Amputation of the Leg by the Mixed Method.

In amputation of the fore-arm the mixed form is *the* operation, the skin flaps being made from the anterior and posterior aspects of the limb, the flap amputation executed by transfixion being very unsatisfactory, on account of the tendons of the fore-arm (Fig. 703).

In amputation at the wrist and elbow-joints nothing can be better than this mixed method (Figs. 701, 702), the surgeon having it in his power, according to circumstances, to make one long anterior, posterior, or lateral flap cover the stump, and thus to secure the cicatrix being out of harm's way. One of the best stumps of this kind I ever obtained was at the elbow-joint, in which I made a long skin posterior flap, the cicatrix subsequently being placed above the condyles of the bone and in front (Fig. 702).

SPECIAL AMPUTATIONS.

The subject of amputations as a whole having been considered, I propose now to describe them in detail as applicable to different parts of the body, and begin with the upper extremity.

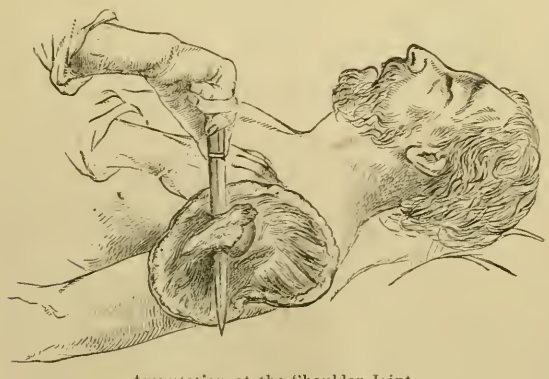
Amputations at the Shoulder-Joint.

This operation may be called for in cases of injury when the arm has been so irreparably injured as to render amputation through the tuberosities impossible or excision inapplicable, or for disease when too extensive to be taken away by a less severe measure, the surgeon always bearing in mind that large portions of the humerus may be resected with advantage so long as the chief vessels and nerves of the arm are intact, and that amputation through the humerus, however high, leaves a far better stump than at the joint.

After this operation, when performed for injury, 1 out of 3 cases die; but when for disease, 1 in 2.

The operation is best performed by means of the double flap operation. A good assistant is required, to compress the subclavian artery above the clavicle or to take charge of the axillary in the lower flap. When the right arm has to be amputated the surgeon should stand behind, and when the left in front, of his patient (Fig. 699); under both circumstances a deltoid flap should be first made, cutting from without inward between the posterior part of the axilla and an inch in front of the acromion process, this incision including in its sweep the whole deltoid muscle. Having reflected this flap with a few bold sweeps of the knife, the head of the humerus should be disarticulated, the knife being kept close to the bone, and the lower flap made, three or four inches long, by cutting from within outward. If this part of the operation is done

Fig. 699.



Amputation at the Shoulder-Joint.

with care, the main artery of the limb will be divided only on the completion of the second flap, when the surgeon with his left hand can secure it between his finger and thumb until it can be either twisted or tied.

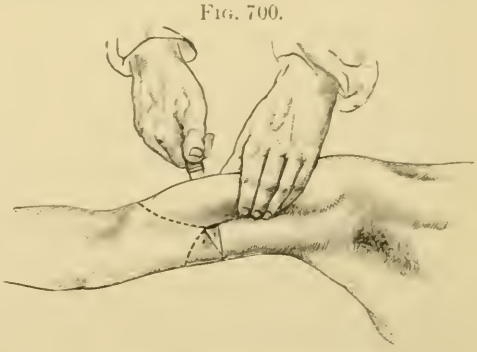
During the first step of this amputation the arm should be held well out by an assistant, but during the second at first near the body; and when the knife has passed beneath the head of the bone, it should be abducted. A very good stump usually follows this operation. At no joint of the body, however, is the surgeon more compelled to form his flaps according to the circumstances of the case than at the shoulder, since the majority of cases of amputation at this part are for injury where the arm has been wholly or partially torn off, when the surgeon must make the best flap he can, and at times no flap at all. As good a stump as any I have made at this joint was one in which a piece of integument from the posterior part of the arm was alone available. I have seen many cases in which the flaps sloughed and yet good cicatrices followed, the soft parts being readily drawn forward by the cicatricial process.

In this amputation some surgeons prefer making an anterior and posterior flap by perforating in front of the posterior axillary fold to make the posterior flap, disarticulating and dividing the axillary artery in the anterior flap; but the operation, although good, is not so efficient as the former.

Amputation at the Arm.

Excision of the elbow-joint, even when three or four inches of the humerus are taken away, is such a very successful operation that amputation at the arm is never called for when excision can be entertained; and this observation applies as forcibly to cases of injury of the elbow-joint as seen in civil and military practice as it does to cases of disease.

Fig. 700.



Amputation of Arm by Flap Operation.

When, however, the fore-arm and elbow-joint are hopelessly injured, gangrenous, or diseased, amputation may be demanded, and, therefore, as the very worst cases are included in this category, the mortality of the operation is great—viz., 1 in 3 for injuries, and 1 in 10 for disease.

The flap operation, as already described, is the best in this region, the anterior flap being made by cutting from without inward toward the bone, excluding the brachial artery, and the posterior by transfixing all that remains. In a very large, muscular arm the skin flap and circular cut through muscle—*i. e.*, the *mixed* operation—may be performed. Amputating by double flaps and transfixion is, however, excellent (Fig. 700).

Amputation at the Elbow-Joint

is a capital operation, and ought always to be performed in preference to any higher operation when amputation above the fore-arm is imperative, if the condition of the soft parts will allow. By this operation an excellent stump is obtained, and, as in other amputations at joints, less constitutional disturbance, and probably less risk to life, is incurred than after amputation through the bones. I have had a patient up and about on the seventh day after such an operation, the wound having united without any traumatic fever or other disturbance.

Fig. 701.

Amputation at Elbow-Joint by Mixed Method.

Fig. 702.

Stump after Amputation at Elbow-Joint.

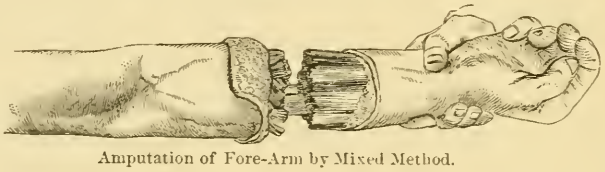
It should be performed by the mixed method of amputating, by anterior and posterior skin semi-circular flaps, beginning and ending at the lower extremities of the condyloid ridges, the muscles being divided transversely on completing the disarticulation (Fig. 701). In the

drawing of the stump (Fig. 702) the posterior flap was made longer than the anterior in order that the cicatrix might be out of harm's way. I have performed this operation on six occasions, and the result in all was so good that I cannot too strongly advocate it whenever the injury or disease will allow; in fact, it ought to be performed whenever enough integument can be saved to cover the bone and the disease or injury for which amputation is called for has not attacked the humerus.

Amputation at the Fore-Arm.

This is comparatively a rare operation, modern surgeons doing their utmost to save the hand. It is, consequently, performed only when the hand is hopelessly crushed or so extensively diseased as to forbid any other treatment being entertained. At Guy's Hospital it was performed only 84 times in thirty years ending 1874—on 44 occasions for injury, 9 patients dying, or 1 in 5, and on 40 occasions for disease, with 5 deaths, or 1 case in 8—the operation being used in the very worst cases. Amputa-

Fig. 703.



Amputation of Fore-Arm by Mixed Method.

tion of the fore-arm ought always to be performed by the mixed method, the one by transfixing being very unsatisfactory, the many tendons, etc., of the part causing ragged flaps, and thus favoring suppuration. Two well-cut and fairly-long semi-circular skin flaps and a clean circular section of the muscles are preferable to the flap operation and yield a good stump (Fig. 703). The skin is usually too thin for one long skin flap, and there are too many tendons for a Teale's.

Amputation at the Wrist-Joint.

I have never performed this operation or seen it done, but I have seen two cases in which it had been performed years before for injury, and in both the stumps were constant sources of trouble to their owners during the winter months, from their being the seat of chilblains and ulcerations on account of the feebleness of the circulation through the thin cutaneous covering, and in neither could a good hand be fitted with comfort. Both patients likewise regretted that the amputation had not been performed higher up.

Under these circumstances I am disposed to follow the opinion of my patients, and cannot advocate the operation. If, however, it be called for, it should be performed with skin flaps and the circular division of the deeper tissues or by the pure circular operation.

Amputation of the Thumb and Fingers.

A knowledge of the shape of the articular ends of the bones and of the position of the different articulations of the hand is of importance in all operations on these parts, and I have, therefore, supplied a figure to illustrate these points as much as possible (Fig. 704).

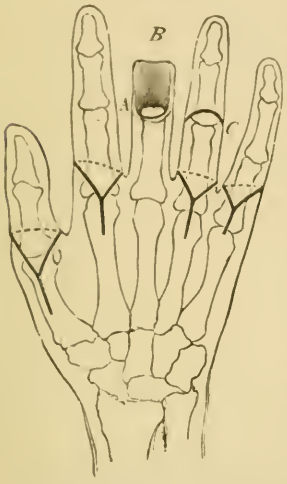
The surgeon should remember that with the hand closed the knuckles are formed by the heads of the metacarpal bones, the bases of the phalanges being in front, and that in the second and third rows the same arrangement holds good. To open any of these joints, consequently, the line of incision should be anterior to the knuckles on the dorsal aspect and in the fold of the fingers on the palmar. In the figure it will be observed, also, that the two distal joints are concave, with the concavity looking toward the ends of the fingers, while at the metacarpal joints the concavity points the other way, the heads of the metacarpal bones being round; from the palmar surface the metacarpo-phalangeal joints are more than half an inch behind the clefts of the fingers, corresponding pretty nearly with the palmar furrow of the hand; this furrow likewise corresponds with the upper limit of the synovial sheaths of the flexor tendons and with the bifurcation of the digital arteries.

In amputating at the phalangeal joints (Fig. 704, *C*) or through the bones, anterior and posterior semicircular flaps are better than one long flap, although this may at times

be performed with advantage, one long anterior flap (*B*), after opening the joint from its dorsal aspect (*A*), being the most common shape; but the surgeon must in these cases be much guided by what skin he has to utilize. As a rule, it is wise *not* to take off the head of the proximal bone, though when there is not sufficient flap to cover it the surgeon may be justified in removing its head with bone forceps.

Amputation of the fingers at their metacarpal joints requires much nicety, and in all the fingers the surgeon should remember that he is on no account, unless absolutely required, to interfere with the palm of the hand; his incision in the palmar surface must never go beyond the fold of the joint. In performing this operation the surgeon is to take charge of the amputated member, an assistant holding the hand, separating the fingers, and compressing the radial and ulnar vessels. With the hand pronated, a vertical incision about one inch long should be made with a strong scalpel over the dorsal aspect of the head of the metacarpal bone, and from its distal end over the joint the knife should be made to pass up one cleft of the finger close to the bone to be removed, round the palmar surface of the finger in the fold, and through the second cleft to the point from which the circular incision started, the tendons and ligaments being divided as cleanly as possible (Fig. 704). The joint can then be opened and the finger removed. In a laboring-man it is wise *not* to remove the head of the metacarpal bone unless diseased, although in the higher classes it is sometimes expedient to take it away with bone forceps, to allow the neighboring fingers to be brought closer together, and thereby to improve the aspect of the hand. With the same object it is at times wise to take off the head of the metacarpal bone of the little or index finger obliquely—*i. e.*, in a direction sloping upward away from the median line of the hand. In amputating either the little or the index finger at this joint the same form of incision may be made, the outer flap under both circumstances being somewhat larger than the inner, in order that the cicatrix may be placed close to the adjoining finger, and thus out of all harm's way. If the incision be so made as to allow the scar to fall over the exposed aspect of the hand, the result is very inconvenient, and often painful, as the hand naturally rests on its outer borders.

Fig. 704.



Outline Diagram for Amputation of the Thumb and Fingers.

Fig. 705.

Hand after Amputation of Part of Thumb, Index, and two Outer Fingers.

The same arguments apply to the **amputation of the thumb**, one long external skin flap adjusted to a shorter flap in the cleft being far superior to the palmar and dorsal flaps usually adopted. But it may here be stated that amputation of the thumb ought to be a very rare operation, as it is far better practice in all cases of injury to the thumb, where there is no possibility of saving it, simply to cut off any sharp point of bone, trim up the soft parts, and allow the stump to granulate than to make what is sometimes called a good job of it by amputating the organ higher up; for any stump of a thumb, however short or ugly, is of use. In the hand here figured (Fig. 705) the man was an engineer, and he has been able for years to follow his occupation with but little inconvenience.

To describe other amputations of different parts of the hand is unnecessary. As little as possible should be taken away, and this by making skin flaps only, care being always observed to divide the tendons by a clean cut and as high up as possible. The ingenuity of the surgeon and the wants of the individual case will suggest the best means by which the latter can be supplied.

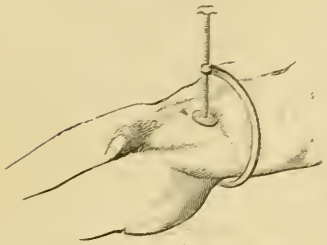
Amputations of the Lower Extremity.

These are of more importance than those of the upper, from their greater severity. They are, moreover, larger operations, more dangerous, and possibly more difficult.

Amputation of the thigh at the hip-joint is a formidable operation and is justifiable only under desperate conditions, when a limb is irreparably crushed or diseased and resection of the head of the femur with more or less of its shaft is out of question.

When performed for accident, it is almost always fatal, not ten per cent. recovering; for disease, however, it is more successful, the risk being about equal, although after resection of the head of the femur which has failed it is somewhat better. The best flaps where F. Jordan's method cannot be carried out appear to be the external and internal. The patient being brought to the edge of the table, with the tuberosities of the ischium in view and hemorrhage controlled by Jordan Lloyd's method (p. 1015) or Lister's tourniquet (Fig. 706), the surgeon should then make the external skin flap by means of a semicircular incision, starting from the tuberosity of the ischium, downward and outward one hand's breadth below the great trochanter, and then upward and forward to the centre of the groin (on the outer side of the femoral vessels). This flap should then be reflected upward, so as to expose the trochanter and allow the joint to be opened and disarticulation to be completed, the limb being forcibly adducted by an assistant to facilitate this step. In doing this no vessels of any importance are divided, while the most difficult part of the operation is performed.

Fig. 706.



Lister's Abdominal Tourniquet.

The inner flap now remains to be made, which is readily done by transfixing the thigh on the inner side, inserting the knife (twelve inches long) in the anterior wound, passing backward close to the inner side of the neck of the femur, and bringing it out near the tuberosity of the ischium where the external incision was commenced, and then cutting out through the soft parts, including the adductors, etc. (Fig. 707). In doing this all the pelvic muscles are separated from the thigh-bone at one clean sweep, and a few touches of the knife complete the amputation. Should there be much cause to fear loss of blood, the common femoral artery may be ligatured in the wound before the second flap is made, or it may be divided and twisted. The vessels can then be secured in the way the surgeon proposes and the parts brought together, the two flaps usually forming an excellent covering to the acetabulum. The wound being an antero-posterior one, and therefore good for drainage, a good scar results.

Fig. 707.

Amputation at Hip-Joint by External and Internal Flaps.

This operation I believe to be better than the anterior and posterior flap usually advised, and which is thus described by Erichsen: "If the operation be on the left side, the knife (twelve inches long) should be entered about two fingers' breadth below the anterior spine of the ilium and carried deeply in the limb behind the vessels directly across the joint, its point being made to issue just above the tuberosity of the ischium. In transfixing on this side care must be taken not to wound the scrotum or the opposite thigh; the back of the knife must run parallel to, but not against, the pelvis, and the point must not be held too high, lest it enter the obturator foramen. The anterior flap must then be rapidly cut downward and forward about five inches in length. The limb must now be forcibly abducted and everted, the capsule of the joint opened. So soon as this is done the head of the femur must be pushed up by forcibly depressing and abducting the limb, so that it may start out of the acetabulum: the heel of the knife is then passed behind it, the remainder of the capsule cut across, and the posterior flap rapidly fashioned by carrying the knife downward and backward through the thick muscles in this situation; the posterior flap may be about four inches long." The operation is then to be completed as the former. In both these operations good assistants are needed to compress the bleeding vessels as they are divided, for hemorrhage and the shock of the operation are the great evils to be feared. Lister's compressor, however, has rendered this serious operation safer than it was.

Furneaux Jordan's Method.[1]—This excellent surgeon of Birmingham has described a method of amputation at the hip-joint which must be regarded as a far better operation than any that has been hitherto described, and it seems to be generally appli-

[1] *Surgical Inquiries*, 1880.

cable, excluding only cases of new growth in which the soft parts around the bone are involved in the disease. It consists in an incision along the outer side of the thigh, extending downward from the top of the trochanter for six or more inches, the enucleation of the head of the femur from the acetabulum and the separation of part of the shaft from its muscular attachments, and finally a circular division of the soft parts down to the bone at any line thought desirable. The surgeon may, if he choose, make the circular sweep through the soft parts before the shaft of the bone is turned out.

Fig. 708

Furneaux Jordan's Method of Amputation at the Hip-Joint.

The periosteum should be saved from the shaft of the femur if possible, and the attachments of the muscles thus saved, when, as shown by Mr. Shuter's case, a firm and movable stump may be obtained to fit into the bucket of an artificial limb and assist progression.

It is better, says its author,[1] to enucleate the femur where it is most thinly covered, and cut across the limb where it is smaller and farther removed from the trunk; it is better, moreover, not to touch the bulky soft parts at the inner and upper parts of the thigh.

In this I quite concur, and from what I have seen of this operation—and it has been performed at least five times at Guy's—I cordially recommend its adoption, and more particularly with the improvement, as made by Shuter, in preserving the periosteum as much as possible.

Mr. Jordan Lloyd, also of Birmingham, has suggested an excellent method of controlling hemorrhage in amputation at the hip-joint which deserves a notice. I have seen it employed with marked success. It is to be applied as follows: The limb to be amputated having been emptied of its blood by elevation and friction toward the trunk, "a strip of black india-rubber bandage about two yards long is to be doubled and passed between the thighs, its centre lying *between the tuber ischii of the side to be operated on and the anus.* A common calico thigh roller must next be laid lengthways over the external iliac artery. The ends of the rubber are now to be firmly and steadily drawn in a direction upward and outward, one in front and one behind, to a point above the centre of the iliac crest of the same side. They must be pulled tight enough to check pulsation in the femoral artery. The front part of the band, passing across the compress, occludes the external iliac and runs parallel to and above Poupart's ligament. The back half of the band runs across the great sacro-sciatic notch, and by compressing the vessels passing through it prevents bleeding from the branches of the internal iliac artery. The ends of the bandage, thus tightened, must be held by the hand of an assistant placed just above the centre of the iliac crest, the back of the hand being against the patient's body. To prevent the bandage slipping, it should be fastened by a safety-pin to the roller" (*Lancet*, May 26, 1883).

Amputation at the Thigh.

Primary amputations of the thigh, taken as a whole, are very serious, and, calculating cases at all ages, more than half die. In subjects under twenty years of age, however, better results can be recorded, the mortality being about half this amount, whilst in those over forty the average is worse, age having here, as elsewhere, a striking influence on results. Primary amputations, however, in the upper third of the thigh are more fatal than those in the middle, and these, again, are more fatal than amputations above the knee, amputations through the condyles or at the knee-joint being better than all. The nearer the operation approaches the body, the greater is the risk. Still, even in the worst cases of compound fracture of the thigh, when death seems inevitable, the surgeon should operate when by so doing any reasonable hope of saving life can be entertained.

In amputations for diseases a better account can be given.

In amputation of the thigh for *chronic joint disease* at all ages the mortality is about 1 in 4, but under the age of twenty 1 in 17, while over that period it is 1 in 3, the difference in the mortality of the operation at the two periods being very great. Thus, taking all cases of chronic disease together, out of 89 of my own, 13 died; of 99 of Callender's, 28; of 54 of MacCormac's (*Dublin Journal*, 1868), 10; and of 106 of Holmes's, 30; making a total of 348 cases, of which 81 died, or 1 in 4. In subjects under twenty years of age, out of 69 cases of Callender's and my own, 4 died, or 1 in 17; and of 119 cases over twenty years of age, 38 died, or 1 in 3; amputation of the thigh for

[1] *Clin. Soc. Trans.*, 1883.

chronic joint disease being nearly six times more successful in early than in middle life.

This operation in the upper or middle third, when the muscles are thick, is best performed by means of anterior and posterior skin flaps and the circular division of the muscle, or by the flap operation as illustrated in Fig. 691, the anterior flap being made by cutting from without inward, and the posterior by perforating. The operation by lateral flaps, whether made of skin or muscle, or skin alone and circular muscle, is not satisfactory, the bones having a tendency to appear at the upper angles between the flaps. In amputation at the lower third one long anterior flap may be made, and a short posterior, as previously described under Garden's operation (Fig. 696).

Mr. W. Stokes of Dublin advocates (*Med.-Chir. Trans.*, 1870; *Dublin Journ. of Med. Sci.*, 1875) the *supra-condyloid amputation* of the thigh, in which the femur is divided at least half an inch *above* the antero-superior edge of the condyloid cartilage, and the patella, deprived of its cartilaginous surface, is applied to the same surface and fixed there with carbolized catgut sutures. The anterior skin flap is made oval, and the posterior fully one-third of the length of the anterior.

I have performed this operation in one case with a good result, and have seen it performed on several previous occasions by my colleagues with success. I think well of it, and would suggest its wider trial. My colleague, Mr. Jacobson, has written an interesting paper on it (*Guy's Hosp. Reps.*, 1878).

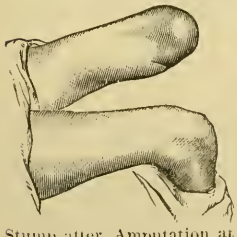
This operation differs from what is known as Gritti's in the section of the femur being about one inch higher up.

Amputation at the Knee-Joint.

This is an excellent operation in all ways, and one that should always be performed in preference to any higher amputation when the special circumstances of the case will allow. It is apparently attended with less risk to life than when a section of the bone is made, and yields an excellent and serviceable stump on which the weight of the body can generally be sustained. Velpeau revived the operation in 1830, while Mr. Pollock recalled the attention of London surgeons to the subject (*Med.-Chir. Trans.*, 1870). In his paper he states that, up to 1870, 48 cases of the kind had taken place in England, and that 12 died, or one-fourth, but since then the operation has been more common.

I have now performed it upward of 23 times—on 7 occasions for compound fracture of the leg, 6 of which recovered; in 13 cases for chronic disease of the knee-joint or leg, 11 of which recovered; and in 3 cases for gangrene of the leg from arterial obstruction, 1 of which alone recovered, the operation in the other 2 having failed to save life. In only 2 or 3 of the cases did I remove the patella. In all the successful cases excellent stumps were obtained (Fig. 709).

Fig. 709.



Stump after Amputation at the Left Knee-Joint.

In performing this operation a long, broad, anterior flap should be made, which must of necessity be of skin, and also a tolerably long posterior, for it is remarkable to what an extent the posterior flap always retracts. I prefer to make my posterior flap about two-thirds the length of the anterior and of skin only, and to divide the muscles and deeper structures by cutting from behind forward about an inch below the joint end of the tibia, and not after disarticulation, the popliteal artery being thus divided low down, where it is readily secured. The patella should not be removed except when diseased.

When the operation has been completed and the articular surface of the femur is found not to be healthy or reparable, or the flaps too short, the condyles should be taken away, a thin rounded section of bone being removed, or more if the necessities of the case demand.

After the operation a troublesome suppuration occasionally takes place in the synovial bursa beneath the extensor muscles of the thigh; and when it occurs, it should be dealt with by free incisions.

Stephen Smith of New York has suggested (*Amer. Journ. of Med. Sci.*, January, 1870) the formation of two lateral skin flaps for this amputation, each flap to be formed by an incision commencing one inch below the tubercle of the tibia and carried downward and forward over the side of the leg (*vide* Fig. 710) until it reaches the under surface, when it is curved toward the median line. I have adopted this method on ten occa-

sions with excellent results, and am disposed to think it the best. The stump left is very good, the cicatrix being vertical and placed well behind the lower end of the femur (Fig. 711).

Amputation at the Leg.

Amputation of the leg for disease is a very successful operation, only about 1 case in 12 proving fatal. In young life it is more successful than at a later period.

Amputations for injury are, however, very unsuccessful, at least sixty per cent., or

Fig. 710.

Stephen Smith's Method of Amputating.

Fig. 711.

Posterior Aspect of Stump after S. Smith's Amputation at Knee-Joint, showing Cicatrix.

more than half the cases, dying. Pyæmia is a more common cause of death after this form of amputation than even after amputation of the thigh, it being fairly proved that the larger the section of the shaft of a bone, the greater the liability to blood-poisoning.

Amputations of expediency in the leg are as dangerous as those for injury.

This operation in the upper two-thirds is doubtless best performed by the mixed method, by two skin lateral flaps and the circular division of the muscles, as already described (Fig. 697). When the condition of the soft parts forbids such an operation, other flaps may be made, any form being allowable to avoid sacrificing more of the limb than is necessary. In the lower third of the leg Teale's amputation is good, the long anterior flap not being too long or so liable to slough. The long muscular flaps, and more particularly the posterior calf flap, cannot be recommended. In the lateral flap operation, Mr. Cock, who always includes the muscles and makes the flaps long, turns out excellent stumps. Some surgeons, in this mixed method, make anterior and posterior skin flaps, but they possess no advantage over the lateral, while the anterior flap, falling over the edge of the tibia, is apt to slough or to form unpleasant adhesions. In dividing the tibia its anterior edge should be rounded off with the saw.

Amputations of the Foot.

In no part of the body has an improvement in surgery shown to greater advantage than in the foot, for in none has so much been done in the way of conservatism. Whereas formerly amputation of the whole foot was common, we have now Hey's, Chopart's, Syme's, Pirogoff's (the subastragaloid), and Hancock's operations, all based upon the well-established position that governs, or *ought to govern*, all amputations—viz., that no more of the body should be removed than the necessities of the individual case require, or, in other words, upon the principle of "the least sacrifice of parts." To amputate a foot where anything less would suffice is in the present age regarded as almost criminal, and surgeons generally accept Hancock's well-put question in his valuable lectures at the college in 1866: "Can anything be more unphilosophical than to advocate the sacrifice of any bone or joint of the foot for no other reason than that a particular operation should be performed?" (*Lancet*, 1866). Indeed, this principle of practice should be uppermost in the mind of every surgeon called upon to treat any local disease, and in the hand and foot it should be so pre-eminently. Accepting this teaching, Hancock's three other dicta necessarily follow:

That we should perform our operation as close to the diseased or damaged structure and preserve as much of the foot as we possibly can do with safety to our patient.

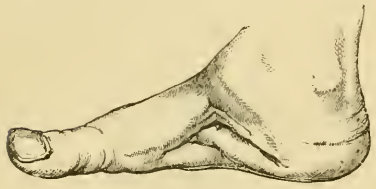
That where practicable we should cut through the tarsal bones with a saw in preference to disarticulating them.

That we should avoid the destruction of parts whenever we can do so.

These views of Hancock accord so closely with those I have attempted to lay down as guides to the surgeon in the surgery of other parts of the body that I have given them in his own words and placed them as leading principles of practice to be observed

in the surgery of the foot. I believe them to be of great practical value, and desire that the student should have them always before him in the treatment of every case of local injury or disease. The principle embodied in *the least possible sacrifice of parts* is one upon which most of the operations of the foot should be undertaken; and it is well to remember that of the different amputations that have been recommended, while none of them are called for until minor measures have altogether failed, each succeeding one is only a degree more severe than the preceding. The surgeon in the present day takes away diseased bone or bones without fear, and leaves nature to repair the breach with every confidence. I have taken away, in one case, the whole second row of tarsal bones, and in another the three cuneiform, scaphoid, and cuboid, with excellent results. I have removed the necrosed os calcis with so little deformity that the loss could hardly be detected, and taken away on several occasions the upper articulating surface of the astragalus for disease with a result which has astonished me, no external deformity remaining and movement of the ankle being almost complete. Mr. Key in 1836 took away the whole of the outer part of the foot for injury, leaving only the os calcis, astragalus, scaphoid, inner cuneiform bone, and great toe (*vide* Fig. 712; *Guy's Rep.*, 1836), from a boy æt. 17 who subsequently had a useful and sound foot. More recently Mr. Birkett has done the same with a like success. Single metatarsal and tarsal bones, when irreparably diseased, may be removed with some confidence of a good result being obtained, and any of the operations I am about to describe should be undertaken only when less severe measures are inapplicable.

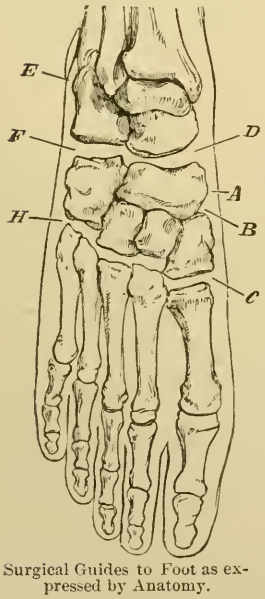
Fig. 712.



Foot after Amputation of the Four Outer Toes with their Metatarsal Bones, Two External Cuneiform, and Cuboid Bones. (Key's case, *Guy's Hosp. Rep.*, 1836.)

Upon this principle the amputations of Hey and of Lisfranc were hailed with satisfaction, Hey's consisting of the disarticulation of the metatarsal bones from the tarsal, or the section with the saw of the metatarsal or tarsal bones, Lisfranc suggesting their disarticulation. Chopart's amputation, again, at the medio-tarsal joints, Syme's amputation at the ankle-joint, and Pirogoff's, which is a modification of Syme's, a part of the os calcis being preserved, have all the same end in view. The sub-astragaloid amputation, as recorded by Malgaigne, to save the astragalus and ankle-joint, is based upon the same principle, and Hancock's amputation to save the posterior part of the os calcis with the astragalus goes still farther in the way of conservatism.

Fig. 713.



Surgical Guides to Foot as expressed by Anatomy.

All these operations have their own value and each is applicable to its own class of cases. Where the minor measure will suffice the major is out of all question, the principle of the least possible sacrifice of parts being the one upon which they, as all other amputations, should be based.

Before considering the different forms of amputation it will be well to consider briefly the surgical guides to the foot as expressed by its anatomy, for, although in cases of disease these guides are greatly obscured, they are still of value, and in cases of injury they are always reliable. The accompanying figure will help the student.

On the *inner* side of the foot, not far from the inner malleolus, the tubercle of the scaphoid (*A*) is to be felt as a marked prominence; about half an inch in *front* of this will be found the articulation with the cuneiform bone (*B*), and one inch beyond this the joint which the surgeon will have to open in Lisfranc's or Hey's operation (*C*); just above the tubercle of the scaphoid will be found the articulation with the astragalus, the line of Chopart's amputation (*D*).

On the *outer* side of the foot, one inch below the external malleolus, a sharply-defined projection will always be felt, which is the peroneal tubercle (*E*), and half an inch in front of this will be found the joint which separates the os calcis from the cuboid, this joint forming the outer circle to Chopart's amputation. Half an inch in front of this, again, or one inch from the tubercle, the prominence of the fifth metatarsal bone is always to be felt (*H*), the line above this prominence indicating the

articulation with the cuboid bone which forms the outer boundary of the incision for Hey's or Lisfranc's operation.

All these points should be looked for in a healthy foot, and learnt so as to be readily recognized in the injured or diseased.

Hey's Amputation (Lisfranc's).—The credit of introducing this operation must be accorded to Hey, for the date of the first case that he published was 1797, whereas Lisfranc's paper was only published as a suggestion in 1815.

The operation consists in the removal of all the toes with the metatarsal bones by disarticulation, although it seems, from reading Hey's observations (1814), that disarticulation of the metatarsal bones was not essential, since in one of the two cases recorded the cuboid bone was removed with some part of the astragalus, and in the second "the projecting part of the first cuneiform bone which supports the great toe was divided with a saw;" and in others he stated that he sawed through the metatarsal bones when the joints were not removed.

"The operator," writes Malgaigne in describing it, "should use a small knife with a solid strong back and only one edge. In operating on the right foot the patient should lie on his back, and the surgeon, facing the foot, should grasp it with his left hand, the thumb and finger respectively resting on the well-marked bony projection of the metatarsal bone of the little toe, and the base of that of the great toe placed one inch in front of the tubercle of the scaphoid. Half an inch in front of these points an incision with its convexity downward is to be made across the dorsal aspect of the foot, dividing all the soft parts down to the bones by a second cut. The plantar flap is then to be made by two lateral incisions carried from the base of the dorsal flap along the metatarsal bones, and joined by a curved incision made on a line beyond the ball of the great toe. This flap is to be longer on the inner than on the outer side, because the internal cuneiform bone is thicker than the cuboid, and it is to include all the tissues down to the bones. Disarticulation has next to be performed, and this is best done from the dorsal region when the parts are put firmly on the stretch by depressing the toes. The operator then places the point of the knife on the outside of the joint, and, carrying its edge inward, he opens it as far as the third metatarsal bone. Around here he carries the knife half a line forward, incises almost transversely, and thus reaches the second metatarsal. Here he must above all things remember the general precept not to engage his knife in the joint, but to work only with its point and to confine himself to the division of the ligaments. When this instrument has reached the second metatarsal bone, he quits this side of the articulation to attack the inner side. This is well done by inserting the knife between the shafts of the first and second metatarsal bones with its edge upward, and with a backward-and-forward motion dividing the ligaments holding the second bone in place, this fact being indicated by the sudden loss of resistance which the surgeon feels when pressing the toes downward, and by the sudden separation of the tarsus from the metatarsus. Disarticulation is then to be completed and the plantar flap shaped by cutting forward close to the bone. A long dorsal flap may be made when the plantar flap must be short."

Fig. 714

Stump after Hey's Amputation. (From Hey's work.)

The parts are then to be brought together by sutures, after securing the vessels by torsion or the ligature and cutting off ragged tendons. The foot should be fixed upon a splint, with the leg semiflexed upon its outer side, and treated on ordinary principles.

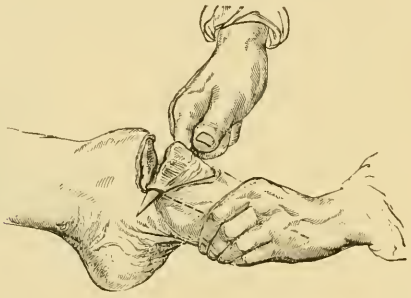
The stump left after this operation is good, and the operation one that ought to be performed when the toes and metatarsal bones alone require removal.

Chopart's amputation is an excellent and valuable operation, and should always be performed in preference to any higher measure when disease or injury is confined to the fore part of the foot. The great theoretical objection brought against it—the subsequent drawing up of the heel and the consequent pointing of the stump—has really little weight, since it can be provided against by the division of the tendo Achillis at the time of the operation, or subsequently, should the difficulty occur. In many cases of my own the tendons have never been divided. My colleague, Mr. Cock, who has performed this operation many times, thinks most highly of it, and never has had to amputate subsequently on account of the pointing of the stump. He believes that this can always be prevented or cured by the division of the tendo Achillis on the first indication of such a malformation. It was introduced into English practice in 1828 by the late Mr. James of Exeter, and to the notice of Scotch surgeons by Professor Syme, who subsequently, however, renounced it in favor of his own operation at the ankle-joint. He did so on

account of the objection already stated, and because in such partial amputations the part of the tarsus left behind, though apparently sound at the time, may become affected with the same disease at a later period. But such an argument may be brought against all operations less than the removal of a diseased part far from the seat of mischief, and is now fairly repudiated by modern surgeons. In fact, all excisional and conservative surgery is based upon an opposite supposition, the local nature of disease becoming daily more acknowledged and acted upon.

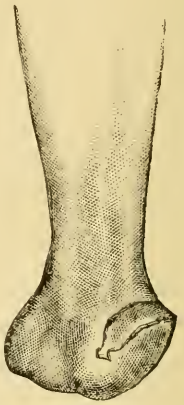
Operation.—The operation may be described as the amputation of the fore part of the foot anterior to the astragalus and os calcis, or as the medio-tarsal amputation. On the right foot it should be commenced by making a slightly convex flap from the dorsal aspect of the foot, commencing half an inch behind the prominence of the metatarsal bone of the little toe and terminating at the tubercle of the scaphoid, the surgeon grasping the foot with his index finger on one point and his thumb on the other. The skin is the first part to be divided, and subsequently, on the level of its retraction, all the tendons, etc., are cut through down to the bones or joints; the articulations are then opened, beginning at the scaphoid joint; the foot should be forcibly bent downward, to facilitate this part of the operation; the plantar flap is to be made by cutting forward, and in doing this care should be observed to keep the knife close to the bones on the sole of the foot, in order that the soft parts may be divided with as clean a cut as possible; the flap should be long and extend as far as the balls of the toes, and longer on its inner than on its outer aspect (Fig. 715). All ragged tendons may be cut off short and the parts brought together. If there be any difficulty in bringing up the fore part of the stump or any retraction of the heel, the tendo Achillis should be divided at once; but if no such difficulty is experienced, such a measure is unnecessary. In dressing the stump a good opening for drainage should be left. Fig. 716 illustrates the condition of the stump a year after the operation, in which the tendo Achillis was not divided.

Fig. 715.



Chopart's Amputation.

Fig. 716.



Stump after Chopart's Amputation.

On one occasion I performed this medio-tarsal operation for injury, making two lateral flaps from the dorsum and sides of the foot, the integument of the sole having been destroyed. A good stump resulted.

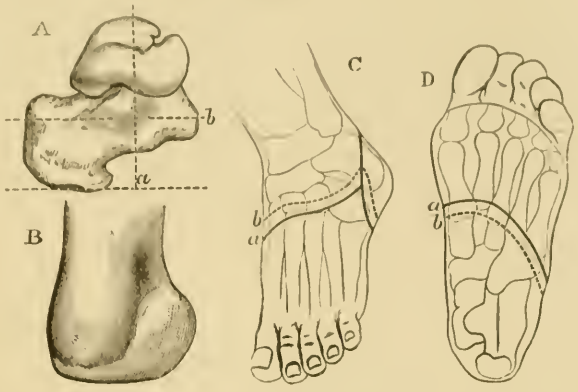
Tripier's Amputation.—The amputation of the foot devised by Tripier of Lyons as a substitute for Chopart's claims a notice, since it professes to possess all the advantages of the Chopart and none of its disadvantages. It includes a horizontal section of the os calcis on a level with the sustentaculum tali (Fig. 717, A), and gives a flat surface to stand upon instead of the posterior part of the os calcis and the unsupported anterior extremity of the bone.

The operation is described in the *Brit. Med. Journ.* (February 26, 1881), but I prefer the description of it given by P. Hayes of Dublin in the *Dublin Journal* (December 1, 1881).

Operation.—The surgeon's knife is caused to take the following course: Commencing at the outer edge of the tendo Achillis, on a level with the external malleolus (Fig. 717, C), a skin wound is to be made in a direction at first downward and forward, and afterward forward, so as to pass two fingers' breadths below the malleolus, and then to approach to within a finger's breadth the upper part of the base of the fifth metatarsal bone. From this point the incision is to be carried upward, forward, and inward, so as

to reach the inner margin of the tendon of the extensor hallucis proprius just behind the first metatarsal articulation. The knife should now be made to cut downward and forward, so as to enter the sole of the foot a finger's breadth in front of the dorsal wound. The incision is then to be carried with a gentle forward curve outward and backward

FIG. 717.



Tripier's Amputation of the Foot.

until it can be made continuous with the first portion of the wound below the outer malleolus (Fig. 717, D). The divided integument having undergone some degree of retraction, the dorsal and plantar structures are to be divided half an inch behind the superficial wound; the soft parts are then to be separated from the bones, extreme care being taken to preserve uninjured the vessels contained in the inner part of the plantar flap.

The surgeon will find it convenient at this stage to disarticulate the cuboid and scaphoid from the os calcis and astragalus, just as in Chopart's amputation. Having done so, he will proceed to divide and separate the periosteum from the under surface and posterior extremity of the os calcis up to the level of the sustentaculum tali, where the bone is to be sawn through in a direction from behind and within, forward and outward, so as to leave a surface which will be at right angles with the axis of the tibia when the limb is caused to assume the ordinary position for walking or standing (Fig. 717, A).

All sharp bone edges and angles should now be rounded off. The posterior tibial nerve is to be exposed in the plantar flap and divided as high as possible, with a view to prevent risk of neuroma. The vessels having been secured and drainage tubes having been inserted, the flaps are to be brought together and the limbs so dressed as to secure moderate flexion of the ankle-joint during the period of repair. M. Tripier attaches importance to the preservation of the periosteum covering the under surface of the os calcis when it is possible to do so. The stump yielded is a good one (Fig. 717, B).

Subastragaloid amputation follows next in order amongst the amputations of the foot, and is the removal of as much as is taken away in Chopart's amputation, with the addition of the os calcis. It has been performed when the disease for which an operation is required involves these parts and yet leaves the astragalus and ankle-joint sound. It seems, according to Velpeau (*Operative Surgery*, 1839), to have been first performed by M. de Lignerolles, and subsequently by Textor, although Malgaigne in 1846 described the operation as his own without mentioning these facts.

It is made by a heel flap, as in Syme's amputation, and a dorsal flap, as in Chopart's, the foot being removed by opening the joints between the scaphoid and astragalus, and that between this latter bone and the calcis.

"The stump resulting from the subastragaloid amputation appears to me," writes Hancock, "to be perfect; it is round and of good form, the cicatrix is firm and well up in front, and the bottom of the stump is perfectly covered by the natural heel tissue." Nélaton says this form of amputation "has been found to surpass all amputations" (*Clin. Surg.*).

I am surprised at these opinions, for in the two cases I have had of it, though the repair was good, the stumps were not to be compared with those of a Chopart, a Pirogoff, or a Syme. I shall never do it again.

Hancock's operation must be looked upon as a modification of the subastragaloid, in the same way as Pirogoff's is a modification of Syme's; for Hancock saves the tuberosity of the os calcis and turns it up, to be united to the lower surface of the astrag-

alus, from which he takes a slice of bone. It may be adopted when, in his attempt to perform the subastragaloid operation, the surgeon finds the lower surface of the astragalus diseased and the os calcis sound. Mr. Hancock performed it in 1864 with an excellent result. The incisions are very similar to those required in the subastragaloid, the end of the os calcis being divided in a line corresponding to the heel flap, instead of the flap being reflected. In the *Lancet* for 1866 full particulars of Hancock's operation may be read, as described by him in a lecture at the College of Surgeons.

Syme's Operation.—This consists in the removal of the whole foot with the articular surfaces of the bones of the leg just above the malleoli, a covering for the osseous surfaces being provided from the integument of the heel, the result being, adds Lister, "a stump admirably fitted for bearing the weight of the body. At the same time, the parts likely to originate carious disease are completely got rid of; so that this operation is calculated to supersede entirely that of Chopart, besides taking the place of amputation of the leg in the majority of cases formerly supposed to demand it" (*Holmes's Syst.*, vol. iii., 3d ed., p. 715).

This view of the operation, which was also held by its originator, emanating from one who was so closely connected with Syme, professionally and otherwise, is doubtless far too sanguine.

That the operation is good no surgeon will deny when amputation of the whole foot is called for, but to say that it will supersede entirely Chopart's operation is to say what I trust never will be true; for when the bones of the ankle-joint and the joint itself are sound, no surgeon ought to take away the whole foot if any minor measure will suffice. Where Chopart's amputation is applicable Syme's ought not to be entertained. As an amputation of the foot where the whole foot must be sacrificed it is admirable, but under no other circumstances can it be recommended; that it is superior to amputation of the leg most surgeons will admit, upon the same principle that Chopart's is superior to it—on the principle of the least possible sacrifice of parts.

It is, however, a successful operation, Hancock reporting (*Lancet*, 1866) that out of 219 cases only 17 died, or 7½ per cent.; 181 were operations for disease, and of these 11 died, or 6½ per cent.; 32 for accidents, of which 6 died, or 13 per cent. The experience of the American war speaks also in its favor, for out of 67 cases only 9 died, or 13½ per cent.

Operation.—The operation is performed as follows (I give it in Syme's own words): "The foot being held at a right angle to the leg, the point of a common straight bistoury should be introduced immediately below the fibula, at the centre of its malleolar projection, and then carried across the integuments of the sole in a straight line to the same level on the opposite side. The operator, having next placed the fingers of his left hand upon the heel and inserted the point of the thumb into the incision, pushes in the knife with its blade parallel to the bone and cuts close to the osseous surface, at the same time pressing the flap backward until the tuberosity is fairly turned, when, joining the two extremities of the first incision by a transverse one across the instep, he opens the joint, and, carrying his knife downward on each side of the astragalus, divides the lateral ligaments so as to complete the disarticulation. Lastly, the knife is drawn round the extremities of the tibia and fibula, so as to expose them sufficiently for being grasped in the hand and removed by the saw. After the vessels have been tied (twisted), and before the edges of the wound are stitched together, an opening should be made through the posterior part of the flap where it is thinnest, to afford a dependent drain for the matter, as there must always be too much blood retained in the cavity to permit of union by the first intention. The dressings should be of the lightest description. That the flap may, and probably will, still occasionally slough is unhappily too true, but this result is always owing to an error in the mode of performance; for as the integument, being detached from its subjacent connections, can derive nourishment only from the anastomosing of vessels, it is evident that if scored crossways, instead of being separated by cutting parallel to the surface, the flap must lose its vitality."

Instead of dissecting the heel flap from the calcis at an early period of the operation, it is a better and simpler practice to do this after the foot has been disarticulated, the surgeon, with the foot in his hand, readily separating the heel flap from above.

In Syme's first operation, in 1842 (*Observations in Clinical Surgery*, 1861), he simply took away the malleolar projections and did not remove the articulating surface of the tibia, as subsequently advised; and it is still an open question whether any advantage is gained by this extra section of bone. I have performed this operation by Syme's original method with an excellent result.

The stump following the amputation is excellent. Fig. 718, taken from Fergusson's lectures on the progress of surgery, illustrates it admirably: "The very bit of soft material on which we naturally stand is still preserved for the future basis of this support."

Fig. 718.

Stump after Syme's Amputation. (From Fergusson.)

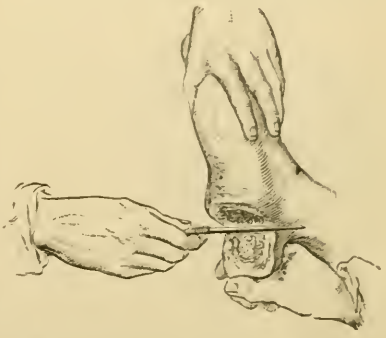
Some surgeons, and Pirrie amongst them, perform the operation by sawing through the tibia and fibula without disarticulating the foot. The modification is good.

Roux's amputation differs from Syme's only in the flap being made from the inner and under side of the heel. I have on one occasion made a long anterior flap—the only one the condition of the parts permitted—with success.

Pirogoff's Amputation.—This operation is to be regarded as a modification of Syme's, and was introduced by its distinguished originator during the Crimean war. The merit he claims for it is the novel osteoplastic principle that, a portion of one bone remaining naturally connected with soft parts, readily unites with another, and at the same time serves to lengthen the limb and increase its utility. It differs from Syme's in leaving the tuberosity of the os calcis in the heel flap instead of dissecting it out and bringing up its exposed cut surface to unite to the divided extremities of the tibia and fibula. I have frequently performed it, and in every instance with a good result. Busk was the first surgeon who did it in this country, in 1857.

The limb is longer than after Syme's amputation, and the stump is not to be excelled (Fig. 721), since a patient can walk upon it as well as if no amputation had been performed. The incisions are the same as in Syme's, but no heel flap is dissected up. After disarticulating and dividing the lateral ligament sufficiently far for the os calcis to become visible behind the astragalus, the surgeon has to saw through the os calcis in the line of the heel and remove the foot, subsequently taking off the ends of the tibia and fibula.

Fig. 719.

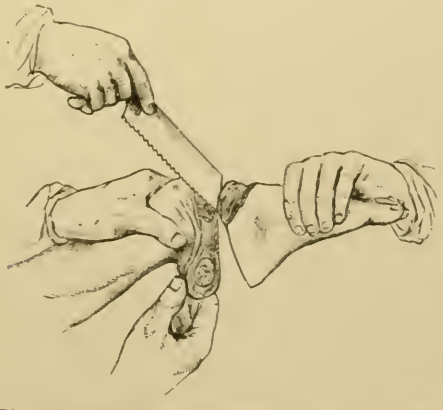


Pirogoff's Amputation. (Heel flap with calcis.)

Dr. Eben Watson, after having made the heel flap, prefers, before going farther, to saw off as much of the os calcis as he wants to save; but there is an objection to this practice, as I have known the incision through the bone to be made too far forward into the astragalo-calcanean joint, and a second slice have to be removed. Dr. Watson also adopts Pirrie's practice of dividing the tibia and fibula without previous disarticulation of the foot (Figs. 720 and 721).

When this method is employed, the surgeon should make a more oblique section of the os calcis from below backward.

Fig. 720.



Pirogoff's Amputation. (Division of malleoli. Taken from T. Smith's work.)

Fig. 721.

Stump after Pirogoff's Amputation.

I regard Pirogoff's amputation as very good, and it yields an excellent stump (Fig. 721); it ought always to be preferred to Syme's when the os calcis is sound. If the bone at the time of the operation be found to be bad, it must be removed, the operation resolving itself into a Syme's; but when the bone is good, it appears to be a grave error to take away what makes so good a point of support to the body.

Hancock records 58 cases of this operation as performed by British surgeons; 5 only, or 9 per cent., died.

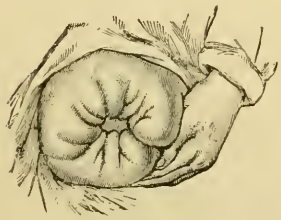
Amputation of the toes may be performed in the same way as amputation of the fingers already described, equal care being observed not to interfere with the plantar surface of the foot. In amputating the great or little toes the same oval flaps should be made as were recommended in amputation of the thumb and little finger (page 1012). They should always be large and as much skin saved as the case will allow.

Stumps, and their Morbid Conditions.

To secure a good stump is desirable, although to obtain it by taking away more of the body than is required by the exigency of the case no increased risk to life should be incurred. Many of the most promising stumps after an amputation often turn out badly, while the least promising end well, the result depending more probably on their subsequent dressing than on the condition of the flaps at the time, it being quite certain that bad dressing may destroy the best stumps and good dressing improve the bad. Still, the character of the stump is much determined by the form of amputation that has been performed.

The stump after a circular amputation (Fig. 722) is not so good as that obtained after a flap (Fig. 723). The stump left after the mixed form of amputation of the leg leaves

Fig. 722.

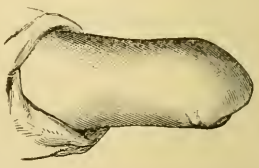


Thigh Stump after a Circular Amputation of Thigh.

Fig. 723.

After a Flap.

Fig. 724.

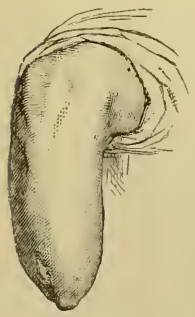


Stump after Amputation at the Knee-Joint.

nothing to be desired (Fig. 698), and that which is met with after amputation at the knee-joint when the patella is left is unexceptionable (Fig. 724).

A conical stump (Fig. 725) is always regarded as a bad one, and yet most thigh and arm (single-bone) stumps after primary amputation become conical by time, the soft parts and muscles wasting, except in very fat subjects. When double bones exist, this evil is rarely seen, nor is it after amputation at the joints. Knee and elbow stumps and Pirogoff's are the best we see.

Fig. 725.



Conical Stump.

A stump that looks well after an operation, with a mass of muscle covering it, is sure to undergo a change; the muscles will degenerate, and after losing all their characteristic features turn into fibro-cellular tissue, of which, and of fatty tissue, a good stump is formed. The end of the bone will become rounded off and its medullary canal filled up; the nerves of the stump also will become bulbous to a degree, but painful only when they are involved in the cutaneous cicatrix or bound down to the bone.

At times, however, stumps grow and become conical, and in the amputations of childhood this condition must be expected. It is best seen in the leg, as it so happens that the shafts of bones grow most where they come in contact with the larger epiphyses, and in the leg the one entering into the knee-joint is the larger. In the case of a boy æt. 7 whose leg I had to amputate, with some irregular skin flap, for a compound fracture, just below the knee, I have had to take away on two occasions, at intervals of three years, two pieces of bone at least an inch long, purely from the growth of the bone during childhood; and it was interesting to notice that the tibia on both occa-

sions had grown at least twice as much as the fibula; in my second operation I never touched the fibula.

Painful stumps are most distressing, and are commonly caused by some increase in the bulbous condition of the divided nerves, the nerve being included in the cicatrix or pressed upon by the bone; and under such circumstances a cure is readily effected by the removal of the bulbous nerve. But in others the extreme pain seems to be due to hyperæsthesia which is often called hysterical, the slightest touch of the end of the stump being sufficient to cause convulsive twitchings of the limb and pain flying up the stump. In these cases operative interference cannot be recommended, although nerve stretching has been advocated. The general condition of the body usually associated with this affection requires attention; tonics are always required, with local soothing anodyne applications such as belladonna, opium, or stramonium ointments, etc.

Necrosis of the stump is a common condition, and it is often due to too great a separation of the periosteum from the bone at the time of the operation by the forcible traction of the flaps backward, and at times to a distinct endostitis of the divided bone (osteo-myelitis). In the former case the necrosis is limited and will probably show itself only as a ring of bone, which may come away by itself or be removed. In the latter more or less of the shaft of the bone dies and subsequently exfoliates, the periosteum forming a new casing or sheath of bone to supply the dead bone's place, as in cases already described in the chapter on ostitis. The largest sequestrum I was ever called upon to remove from a stump was from the femur of a man whose lower extremity I amputated for disease of the knee-joint consecutive to acute necrosis of the tibia. The femur became inflamed by endostitis after the amputation, and ended in endosteal necrosis. The sequestrum was five inches long. I drew it out of the end of the stump some months after the amputation, and an excellent stump was left. I have had also a similar case in a child about six years old, necrosis of the stump following amputation for acute necrosis of the tibia extending into the knee-joint. The stump united after the operation by primary union, but the bone subsequently appeared in the wound as a necrosed mass, this change being attended with slight constitutional disturbance. In exceptional cases the soft parts slip away from the bone and retract as a whole, the stump bone suddenly protruding through them for some inches (Fig. 726). In these cases the periosteum covering the bone, having inflamed, retracts with the soft parts, and so leaves the bone, which, deprived of its periosteum, projects from between the flaps as a dead or dying portion, the result of periosteal necrosis. Under these circumstances the stump must be reopened and the end of the bone removed high up.

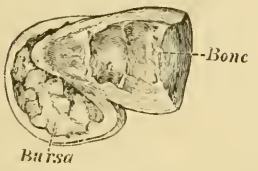
FIG. 726.

Necrosis of a Stump.

Sir Joseph Fayrer tells us (*Clin. Surg.*, 1866) that in India this osteo-myelitis of the ends of stumps is a common affection, and often attended with severe constitutional symptoms such as are well known to accompany all cases of acute *endostitis* with or without amputation. He regards the affection as so serious that he advocates the reamputation of the limb above the next joint as soon as the earliest symptoms of systemic infection appear, blood poisoning being the chief danger of the disease. "The proper time," he writes, "for amputation in cases of diffused osteo-myelitis is as soon as possible after you have ascertained that the bone is affected, and the mode of arriving at this knowledge is simply the passage of a long probe down the medulla. Should it impinge on healthy and bleeding medulla near the surface, you may, if the constitutional symptoms permit, wait and see if nature is about to limit the suppuration and throw off the diseased bone, which is a rare result. Should it pass well up the bone, its whole death is certain. In cases of incipient inflammation the medulla will be found protruding like a fungus from the central cavity and the bone surrounding it exposed to a greater or lesser extent; at a later period the end of the medulla is found already dead, blackened, and encrusted, but within it is a putrid mass of bone, *débris*, and pus. In the former stage you can watch the progress of the case. In the latter interference is immediately necessary; and that, I fear, can be nothing short of amputation, either about the next joint or perhaps, in a young subject, at the epiphysis. The condition of the soft parts must not deceive; the condition of the bone and the constitutional symptoms must be the guide as to the time and necessity for operations." I have made this long extract from Sir Joseph Fayrer's paper

because it is through him that in recent times the subject has been brought prominently under notice, though Longmore and Holmes in this country have ably dwelt upon it, and Roux of Toulon made it the subject of a special report.

Fig. 727.



Removed from John S——, æt. 16, who had had his Arm Amputated Four Years previously for an Accident.

In acute cases there can be little doubt as to the wisdom of the practice suggested, but in English practice they are not, however, of great frequency, the cases of necrosis of stumps met with being generally of a more chronic or subacute kind, of either periosteal or endosteal origin, and not requiring such active treatment.

Aneurismal enlargement of the arteries of a stump has been described by Erichsen on Cadge's authority, and is an accidental association.

Cancer may also attack a stump. In December, 1871, I removed the leg-stump of a man æt. 58 for extensive cancerous disease of two years' standing, which attacked the cicatrix that had been formed fifty-four years (*vide* Fig. 34, p. 136). In this case amputation of both legs had been performed for gangrene of the limb when the patient was a child four years old.

When the end of the bone in a stump is not well covered and is subjected to pressure, a bursa at times forms as a protective agent. This occurred in the case from which Fig. 727 was taken. I amputated the end of the humerus with the bursa, and a good stump was left.

To Prepare and Clean Sponges.

Having shaken them to get rid of sand, and washed them to remove dirt, place them in water acidulated strongly with muriatic acid, and there let them remain until all effervescence has ceased and chalk is removed. For this purpose it may be necessary to renew the acid several times.

Let them then be well washed in plain water.

To bleach them, wash them repeatedly in a solution of binoxalate of potash ʒj, ad Oj of tepid water.

After an operation they should be washed in cold water free from blood, and then placed in a solution of carbolic acid, one in eighty, and there left for twenty-four hours. They are then, after another washing in pure water or carbolized water, ready for use. When not at once required, they should be squeezed dry and suspended in a warm room in a porous bag to dry.

Sponges should not be placed too near a fire, since dry heat hardens them, nor should they be washed in a solution of soda unless they are very greasy, since alkalies dissolve spongine or horny tissue and makes it soft and incapable of absorbing moisture.

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